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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

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"DEMONIACAL POSSESSION" AND INSANITY.

PART II.

IN the foregoing chapter we have seen the culmination of the old procedure regarding insanity, as it was developed under theology and enforced by ecclesiasticism; and we have noted how, under the influence of Luther and Calvin, the Reformation rather deepened than weakened the faith in the malice and power of a personal devil. Nor was this in the reformed churches, any more than in the old, mere matter of theory. As, in the early centuries of Christianity, it was to their power over the enemy of mankind in the bodies of men that the priests of the new faith especially appealed in proof of its divine origin and nature, so now the clergy of the rival creeds eagerly sought opportunities to establish the truth of their own doctrines and the falsehood of their opponents' by the visible casting out of devils. True, their methods somewhat differed: where the Catholic used holy water and consecrated wax, the Protestant was content with texts of Scripture and importunate prayer; but the supplementary physical annoyance of the indwelling demon did not greatly vary. Sharp was the competition for the unhappy objects of treatment. Each side, of course, stoutly denied all efficacy to its adversaries' efforts, urging that any seeming victory over Satan was due not to the defeat but to the collusion of the fiend. As, according to the Master himself, "no man can by Beelzebub cast out devils," the patient was now in greater need of relief than before; and more

than one poor victim had to bear alternately Lutheran, Romish, and perhaps Calvinistic exorcism.*

But far more serious in its consequences was another rivalry to which in the sixteenth century the clergy of all creeds found themselves subject. The revival of the science of medicine, under the impulse of the new study of antiquity, suddenly bade fair to take out of the hands of the Church the profession of which she had enjoyed so long and so profitable a monopoly. Only one class of diseases remained unquestionably hers—those which were still admitted to be due to the direct personal interference of Satan—and foremost among these was insanity.† It was surely no wonder that an age of religious controversy and excitement should have been exceptionally prolific in ailments of the mind; and to men who mutually taught the utter futility of that baptismal exorcism by which the babes of their misguided neighbors were made to renounce the Devil and his works, it ought not to have seemed strange that his victims now became more numerous.‡ But so simple an explanation did not satisfy these physicians of souls, or, rather, they devised a simpler one: their patients, they alleged, were bewitched, and their increase was due to the growing numbers of those human allies of Satan known as witches.

Already, before the close of the fifteenth century, Pope Innocent VIII had issued the startling bull by which he called on the archbishops, bishops, and other clergy of Germany to join hands with his inquisitors in rooting out these willing bond-servants of Satan, who were said to swarm throughout all that country, and to revel in the blackest crimes. A half-dozen popes had since reiterated the appeal; and, though none of these documents touched on the blame of witchcraft for diabolic possession, the inquisitors charged with their execution pointed it out most clearly in their infamous hand-book, the "Witch-Hammer," and prescribed the special means by which possession thus caused should be met. These teachings took firm root in religious minds everywhere; and, during the great age of witch-burning that followed the Reformation—when, in Germany alone, according to the most

* For instances of this competition, see Freytag, "Aus dem. Jahrh. d. Reformation," pp. 359–375. The Jesuit Stengel, in his "De judiciis divinis" (Ingolstadt, 1651), devotes a whole chapter to an exorcism, by the great Canisius, of a spirit that had baffled Protestant conjuration. Among the most jubilant Catholic satires of the time are those exulting in Luther's own alleged failure as an exorcist.

† For the attitude of the Catholic clergy, the best sources are the confidential Jesuit "Litteræ Annuæ." To this day the numerous treatises on "pastoral medicine" in use in the older Church devote themselves mainly to this sort of warfare with the devil.

‡ Baptismal exorcism continued in use among the Lutherans till in the eighteenth century, though the struggle over its abandonment had been long and sharp. See Krafft, "Historie vom Exorcismo" (Hamburg, 1750).

moderate estimate, there perished within a single century (1550–1650) by an excruciating death, for this imaginary crime, not less than a hundred thousand human lives—it may well be doubted whether any single cause so often gave rise to an outbreak of the persecution as the alleged bewitchment of some poor mad or foolish or hysterical creature. The persecution thus once under way, it fed itself; for, under the terrible doctrine of "excepted cases," by which in the religious crimes of heresy and witchcraft there was no limit to the use of torture, the witch was forced to confess to accomplices, who in turn accused others, and so on to the end of the chapter.*

The horrors of such a persecution, with the consciousness of an ever-present devil it breathed and the panic terror of him it inspired, could not but itself increase the insanity it claimed to avenge. Well-authenticated, though rarer than is often believed, were the cases where crazed women voluntarily accused themselves of the impossible crime; and one of the most eminent authorities on diseases of the mind declares that among the unfortunate beings who were put to death for witchcraft he recognizes well-marked victims of cerebral disorders; while an equally eminent authority in Germany tells us that, in a most careful study of the original records of their trials by torture, he has often found their answers and recorded conversations exactly like those familiar to him in our modern lunatic asylums, and names some forms of insanity which constantly and unmistakably appear among those who suffered for criminal dealings with the Devil.†

The result of this wide-spread terror was naturally a steady increase in mental disorders. A great modern authority tells us that, although modern civilization tends to increase insanity, the number of lunatics at present is far less than in those ages of faith and in the Reformation period. The treatment of the "possessed," as we find it laid down in standard treatises, sanctioned by orthodox churchmen and jurists, accounts for this abundantly.

* For a much fuller treatment of this phase of the subject, I must refer the reader to my chapter on witchcraft. The Jesuit Stengel, professor at Ingolstadt, who (in his great work, "De judiciis divinis") urges, as reasons why a merciful God permits illness, his wish to glorify himself through the miracles wrought by his Church, and his desire to test the faith of men by letting them choose between the holy aid of the Church and the illicit resort to medicine, declares that there is a difference between simple possession and that brought by bewitchment, and that the latter is the more difficult to treat.

† See D. H. Tuke, "Chapters in the History of the Insane in the British Isles," London, 1882, p. 36; also Kirchhoff, p. 340. The forms of insanity especially mentioned are "dementia senilis" and epilepsy. A striking case of voluntary confession of witchcraft by a woman who lived to recover from the delusion is narrated in great detail by Reginald Scot, in his "Discovery of Witchcraft," London, 1584. It is, alas, only too likely that the "strangeness" caused by slight and unrecognized mania led often to the accusation of witchcraft instead of to the suspicion of possession.

One sort of treatment used for those accused of witchcraft will also serve to show this—the "*tortura insomniæ*." Of all things in brain-disease, calm and regular sleep is most certainly beneficial; yet, under this practice, these half-crazed creatures were prevented, night after night and day after day, from sleeping or even resting. In this way temporary delusion became chronic insanity, mild cases violent, torture and death ensued, and the "ways of God to man" were justified.*

But the most contemptible creatures in all those centuries were the physicians who took sides with religious orthodoxy. While we have on the side of truth a Flade sacrificing his life, a Loos his hopes of preferment, a Bekker his position, and a Thomasius his ease, reputation, and friends, we find, as allies of the other side, a troop of eminently respectable doctors mixing Scripture, metaphysics, and pretended observations to support the "safe side" and to deprecate interference with the existing superstition, which seemed to them "a very safe belief to be held by the common people."†

Against one form of insanity both religions were especially cruel. Nothing is more common in all times of religious excitement than strange personal hallucinations, involving the belief, on the part of the insane patient, that he is a divine person: in the most striking representation of insanity that has ever been made, Kaulbach shows, at the center of his wonderful group, a patient drawing attention to himself as the Saviour of the world.

Sometimes, when this form of disease took a milder hysterical character, the subject of it was treated with reverence, and even elevated to sainthood: such examples as St. Francis of Assisi and St. Catherine of Siena in Italy, St. Bridget in Sweden, St. Theresa in Spain, St. Mary Alacoque in France, and Louise Lateau in Belgium, are typical. But more frequently such cases shocked public feeling, and were treated with especial rigor: typical of this is the case of Simon Marin, who in his insanity believed himself to be the Son of God, and was on that account burned alive at Paris and his ashes scattered to the winds.‡

* See Kirchhoff, as above.

† For names and arguments used by creatures of this sort, see Diefenbach, "Der Hexenwahn vor und nach der Glaubensspaltung in Deutschland," pp. 342–346. A long list of these infamous names is given on p. 345.

‡ As to the frequency among the insane of this form of belief, see Calmeil, ii, 257; also Maudsley, "Pathology of Mind," pp. 201, 202, and 418–424; also Rambaud, "Histoire de la Civilisation en France," ii, 110. For the peculiar aberrations of the saints above named and other ecstatics, see Maudsley, as above, pp. 71, 72, and 149, 150. Maudsley's chapters on this and cognate subjects are certainly among the most valuable contributions to modern thought. For a discussion of the most recent case, see Warlomont, "Louise Lateau," Paris, 1875.

The profundity of theologians and jurists constantly developed new theories as to the modes of diabolic entrance into the "possessed." One such theory was that Satan could be taken into the mouth with one's food—perhaps in the form of an insect swallowed on a leaf of salad. Another theory was that Satan entered the body when the mouth was opened to breathe, and there are well-authenticated cases of doctors and divines who, when casting out evil spirits, took especial care lest the imp might jump into their own mouths from the mouth of the patient. Another theory was that the devil entered human beings during sleep; and, at a comparatively recent period, the King of Spain was wont to sleep between two monks, to keep off the devil.*

The monasteries were frequent sources of that form of mental disease which was supposed to be caused by bewitchment. From the earliest period it is evident that monastic life tended to develop insanity. Such cases as those of St. Anthony and St. Augustine are typical of its effects upon the strongest minds; but it was especially the convents for women that became the great breeding-beds of this disease. Among the large numbers of women and girls thus assembled, many of them forced into confinement against their will, for the reason that their families could give them no dower, subjected to the unsatisfied longings, suspicions, bickerings, petty jealousies, envies, and hatreds, so notorious in convent-life, mental disease was not unlikely to be developed at any moment. Hysterical excitement in nunneries took shapes sometimes comical, but more generally tragical. Noteworthy is it that the last places where executions for witchcraft took place were mainly in the neighborhood of great nunneries, and the last famous victim—of the hundreds of thousands executed in Germany for this imaginary crime—was Sister Anna Renata Sänger, sub-prioress of a nunnery near Würzburg.†

The same thing was seen among young women exposed to sundry fanatical Protestant preachers: insanity, both temporary and permanent, was thus frequently developed among the Huguenots of France, and has been thus produced in America, from the

* As to the devil's entering into the mouth while eating, see Calmeil, as above, ii, 105 106. As to the dread of Dr. Borde lest the evil spirit, when exorcised, might enter his own body, see Tuke, as above, p. 28. As to the King of Spain, see the noted chapter in Buckle's "History of Civilization in England."

† Among the multitude of authorities on this point, see Kirchhoff, as above, p. 337; and, for a most striking picture of this dark side of convent-life, drawn, indeed, by a devoted Roman Catholic, see Manzoni's "Promessi Sposi." On Anna Renata there is a striking essay by the late Johannes Scherr, in his "Hammerschläge und Historien." On the general subject of hysteria thus developed, see the writings of Carpenter and Tuke; and, as to its natural development in nunneries, see Maudsley, "Responsibility in Mental Disease," p. 9. Especial attention will be paid to this in the next chapter of this series—"Diabolism and Hysteria."

days of the Salem persecution down to the "camp-meetings" of the present time.*

At various times, from the days of St. Agobard of Lyons through the Reformation period, protests had been made by thoughtful men against this system. Medicine had made some advance toward a better view, but the theological torrent had generally overwhelmed all who supported a scientific treatment. At last, toward the end of the sixteenth century, two men made a beginning of a much more serious attack upon this venerable superstition. The revival of learning and the impulse to thought on material matters given during the "age of discovery" undoubtedly produced an atmosphere which made the work of these men possible. In the year 1563, in the midst of demonstrations of demoniacal possession by the most eminent theologians and judges—who sat in their robes and looked wise, while women, shrieking, praying, and blaspheming, were put to the torture—a man arose who dared to protest effectively that some of the persons thus charged might be simply insane, and this man was John Wier, of Cleves.

His protest does not at this day strike us as particularly bold. In his books, "De Prestigiis Dæmonum" and "De Lamiis," he did his best not to offend religious or theological susceptibilities, but he felt obliged to tell certain truths, to call attention to the mingled fraud and delusion of those who claimed to be bewitched, and to point out that it was often not their accusers but the alleged witches themselves who were really ailing, and he urged that these be brought first of all to a physician.

His book was at once attacked by the most eminent theologians. One of the greatest men of genius of his time, John Bodin, also wrote with especial power against it, and by a plentiful use of Scriptural texts gained, to all appearance, a complete victory: superstition seemed fastened upon Europe for a thousand years more. But skepticism was in the air, and, about a quarter of a century after the publication of Wier's book, there were published in France the essays of a man, by no means so noble, but of far greater genius—Michel de Montaigne. The general skepticism which his work promoted among the French people did much to strengthen an atmosphere in which the belief in witchcraft and demoniacal possession must inevitably wither. But this process, though real, was hidden, and the victory still seemed on the theological side.

The development of the new truth and its struggle against the old error still went on. In Holland, Balthazar Bekker wrote his book against the worst forms of the superstition, and attempted to help the scientific side by a text from the Second Epistle of St.

* This branch of the subject will be discussed more at length in a future chapter.

Peter, showing that the devils had been confined by the Almighty, and therefore could not be doing on earth the work which was imputed to them. But Bekker's Protestant brethren drove him from his pulpit, and he narrowly escaped with his life.

The last struggles of a great superstition are very frequently the worst. So it proved in this case. In the first half of the seventeenth century the cruelties arising from the old doctrine were more numerous and severe than ever before. In Spain, Sweden, Italy, and, above all, in Germany, we see constant efforts to suppress the evolution of the new truth.

But, in the midst of all this reactionary rage, glimpses of right reason began to appear. It is significant that at this very time, when the old superstition was apparently everywhere triumphant, the declaration by Poulet that he and his brother and his cousin had, by smearing themselves with ointment, changed themselves into wolves and devoured children, brought no severe punishment upon them. The judges sent him to a mad-house. More and more, in spite of frantic efforts from the pulpit to save the superstition, great writers and jurists, especially in France, began to have glimpses of the truth and courage to uphold it. Malebranche spoke against the superstition; Séguier led the French courts to annul several decrees condemning sorcerers; the great chancellor, D'Aguesseau, declared to the Parliament of Paris that, if they wished to stop sorcery, they must stop talking about it—that sorcerers are more to be pitied than blamed.*

But just at this time, as the eighteenth century was approaching, the theological current was strengthened by a great ecclesiastic—the greatest theologian that France has produced, whose influence upon religion and upon the mind of Louis XIV was enormous—Bossuet, Bishop of Meaux. There had been reason to expect that Bossuet would at least do something to mitigate the superstition; for his writings show that in much, which before his time had been ascribed to diabolic possession, he saw simple lunacy. Unfortunately, the same adherence to the literal interpretation of Scripture which led him to oppose every other scientific truth developed in his time led him also to attack this: he delivered and published two great sermons which, while showing some progress in the form of his belief, showed none the less that the fundamental idea of diabolic possession was still to be tenaciously held. What this idea was may be seen in one typical statement: he declared that "a single devil could turn the earth round as easily as we turn a marble."†

* See Esquirol, "Des Maladies mentales," i, 488, 489; ii, 529.

† See the two sermons, "Sur les Démons" (which are virtually but two forms of the same sermon), in Bossuet's works, edition of 1845, iii, 236 *et seq.*; also Dzwiecki, in the "Nineteenth Century," as above. On Bossuet's resistance to other scientific truths, espe-

The theological current, thus re-enforced, seemed to become again irresistible; but it was only so in appearance. In spite of it, French skepticism continued to develop; signs of quiet change among the mass of thinking men were appearing more and more; and in 1672 came one of great significance, for the Parliament of Rouen having doomed fourteen sorcerers to be burned, their execution was delayed for two years, evidently on account of skepticism among officials; and at length the great minister of Louis XIV, Colbert, issued an edict checking such trials, and ordering the convicted to be treated for madness.*

Victory seemed now to incline to the standard of science, and in 1725 no less a personage than St. André, a court physician, dared to publish a work virtually showing "demoniacal possession" to be lunacy.†

The French philosophy, from the time of its early development in the eighteenth century under Montesquieu and Voltaire, naturally strengthened the movement; the results of *post-mortem* examinations of the brains of the "possessed" confirmed it; and in 1768 we see it take form in a declaration by the Parliament of Paris that possessed persons were to be considered as simply diseased.

In England the same warfare went on. John Locke had asserted the truth, but the theological view continued to control public opinion. Most prominent among those who exercised great power against the truth was John Wesley, and the greatness and beauty of his character made his influence in this respect all the more unfortunate. The same servitude to the mere letter of Scripture which led him to declare that "to give up witchcraft is to give up the Bible and to take ground against the fundamental truths of theology," controlled him in regard to insanity. He insisted, on the authority of the Old Testament, that bodily diseases are sometimes caused by devils, and, upon the authority of the New Testament, that the gods of the heathen were demons; he believed that dreams, while in some cases caused by bodily conditions and passions, are shown by Scripture to be also caused by occult powers of evil; he cites a physician to prove that "most lunatics are really demoniacs." In his great sermon on "Evil Angels," he dwells upon this point especially; resists the idea that "possession" may be epilepsy, even though ordinary symptoms of epilepsy be present; protests against "giving up to infidels such proofs of an invisible world as are to be found in diabolic possession," and evidently believes that some who have

cially in astronomy, geology, and political economy, see my previous chapters in "The Warfare of Science."

* See Dagron, p. 8; also Rambaud, as above, ii, 155.

† For St. André, see Lacroix, as above, pp. 189, 190.

been made hysterical by his own preaching are "possessed of Satan." On all this, and much more to the same effect, he insisted with all the power given to him by his deep religious nature, his wonderful familiarity with the Scriptures, his natural acumen, and his eloquence.*

But here, too, science continued its work. The old belief was steadily undermined, an atmosphere favorable to the truth became more and more developed, and the act of Parliament in 1735, which banished the crime of witchcraft from the statute-book, was the beginning of the end.

In Germany we see the beginnings of a similar triumph for science. In Prussia, that sturdy old monarch, Frederick William I, nullified the efforts of the more zealous clergy and orthodox jurists to keep up the old doctrine in his dominions. In Austria, the government set Dr. Antonio Haen at making careful researches into the causes of diabolic possession. He did not think it best, in view of the power of the Church, to dispute the possibility or probability of such cases, but simply decided, after thorough investigation, that, out of the many cases which had been brought to him, there was not one to support the belief in demoniacal influence. An attempt was made to follow up this examination, and much was done by men like Francke and Van Swieten, and especially by the reforming emperor, Joseph II, to rescue men and women who would otherwise have fallen victims to the prevalent superstition. Unfortunately, Joseph had arrayed against himself the whole power of the Church, and most of his good efforts seemed brought to naught. But what the noblest of the old race of German emperors could not do suddenly, the German men of science did gradually. Quietly and thoroughly, by proofs that could not be gainsaid, they recovered the old scientific fact established in pagan Greece and Rome, that madness is simply physical disease. But they now established it on a basis that can never again be shaken; for, in *post-mortem* examinations of large numbers of "possessed" persons, they found evidence of brain-disease. Typical is a case at Hamburg in 1729. An afflicted woman showed in a high degree all the recognized characteristics of diabolic possession. Exorcisms, preachings, and sanctified remedies of every sort in vogue were tried in vain. Milder medical means were then tried, and she so far recovered that she was allowed to take the communion before she died. The autopsy, held in the presence of fifteen physicians and a public notary, showed it to be simply a

* For John Locke, see King's "Life of Locke," ii, 173, 174. For Wesley, out of his almost innumerable writings bearing upon the subject, I may select the sermon on "Evil Angels," and his "Letter to Dr. Middleton"; and in his collected works there are many striking statements and arguments, especially in vols. iii, vi, and ix. See also Tyerman's "Life of Wesley," ii, pp. 260 *et seq.*

case of chronic meningitis. The work of German men of science in this field is noble indeed. A great succession, from Wier to Virchow, have erected a barrier against which all the efforts of reactionists beat in vain.*

In America, the belief in diabolic influence had, in the early colonial period, full control. The Mathers supported it fully, and the Salem witchcraft horrors were among its results; but the discussion of that folly by Calef struck it a severe blow, and a better influence spread rapidly throughout the colonies.

By the middle of the eighteenth century the old belief in diabolic possession had practically disappeared from all enlightened countries. In Protestant Germany, where it had raged most severely, it was, as a rule, cast out of the church formulas, catechisms, and hymns, and became more and more a subject for jocose allusion.† From force of habit, and for the sake of consistency, some of the more conservative theological authorities continued to repeat the old arguments, and there were many who insisted upon the belief as absolutely necessary to ordinary orthodoxy; but it is evident that it had become a mere conventionality, that men only believed that they believed it, and now a reform seemed possible in the treatment of the insane.

But, although the old superstition had been discarded, the inevitable conservatism in theology and medicine caused many old abuses to be continued for years after the theological basis for them had really disappeared. There still lingered also a feeling of indifference toward madmen, engendered by the early feeling of hostility toward them, which sufficed to prevent for many years any practical reforms.

What that old feeling had been, even under the most favorable circumstances, and among the best of men, we have seen in the fact that Sir Thomas More ordered acknowledged lunatics to be publicly flogged; and it will be remembered that Shakespeare makes one of his characters refer to madmen as deserving "a dark house and a whip." And what the old treatment was and continued to be we know but too well. Taking Protestant England as an example—and it was probably the most humane—we have a chain of testimony. Toward the end of the sixteenth century, Bethlehem Hospital was reported too loathsome for any man to enter; in the seventeenth century, John Evelyn found it no better; in the eighteenth, Hogarth's pictures and contemporary

* See Kirchhoff, pp. 181–187; also Längin, "Religion und Hexenprozess," as above cited.

† Luther's great hymn, "Ein' feste Burg," remained, of course, a prominent exception to the rule; but a popular proverb came to express the general feeling: "*Auf Teufel reimt sich Zweifel.*" See Längin, as above, pp. 545, 546.

reports show it to be essentially what it had been in those previous centuries.*

The first humane impulse of any considerable importance in this field seems to have been aroused in America. In the year 1751 certain members of the "Society of Friends" founded a small hospital for the insane on better principles in Pennsylvania. To use the language of its founders, it was intended "as a good work, acceptable to God." Twenty years later Virginia established a similar asylum, and gradually others appeared in other colonies.

But it was in France that mercy was to be put upon a scientific basis, and was to lead to practical results which were to convert the world to humanity. In this case, as in so many others, from France was spread and popularized not only the skepticism which destroyed the theological theory, but also the devotion which built up the new scientific theory and endowed the world with a new treasure of civilization.

In 1756 some physicians of the great hospital at Paris known as the Hôtel-Dieu protested that the cruelties prevailing in the treatment of the insane were aggravating the disease; and some protests followed from other quarters. Little effect was produced at first; but, just before the French Revolution, Tenon, La Rochefoucauld-Liancourt, and others took up the subject, and in 1791 a commission was appointed to undertake a reform.

By great good fortune, the man selected to lead in the movement was one who had already thrown his heart into it—Jean Baptiste Pinel. In 1792 Pinel was made physician at Bicêtre, one of the most extensive lunatic asylums in France; and to the work there imposed upon him he gave all his powers. Little was heard of him at first. The most terrible scenes of the French Revolution

* On Sir Thomas More and the condition of Bedlam, see Tuke, "History of the Insane in the British Isles," pp. 63–73. One of the passages of Shakespeare is in "As you Like It," Act iii, scene 2. As to the survival of indifference to the sufferings of the insane so long after the belief which caused it had generally disappeared, see some excellent remarks in Maudsley's "Responsibility in Mental Disease," London, 1885, pp. 10–12.

The older English practice is thus quaintly described by Richard Carew (in his "Survey of Cornwall," London, 1602, 1769): "In our forefathers' daies, when devotion as much exceeded knowledge, as knowledge now commeth short of devotion, there were many bowssening places, for curing of mad men, and amongst the rest, one at Alternunne in this Hundred, called S. Nunnespoole, which Saints Altar (it may be) . . . gave name to the church. . . . The watter running from S. Nunnes well, fell into a square and close walled plot, which might bee filled at what depth they listed. Vpon this wall was the franticke person set to stand, his backe towards the poole, and from thence with a sudden blow in the brest, tumbled headlong into the pond; where a strong fellowe, provided for the nonce, tooke him, and tossed him vp and downe, alongst and athwart the water, vntill the patient, by forgoing his strength, had somewhat forgot his fury. Then was hee conveyed to the Church, and certain Masses sung over him; vpon which handling, if his right wits returned, S. Nunne had the thanks; but if there appeared small amendment, he was bowssened againe, and againe, while there remayned in him any hope of life, for recouery."

were drawing nigh; but he labored on, modestly and devotedly, apparently without a thought of the great political storm raging about him.

His first step was to throw overboard the whole theological doctrine of "possession," and to discard utterly the idea that insanity is the result of any subtle spiritual influence. He simply put in practice the theory that lunacy is the result of bodily disease.

It is a curious matter for reflection that, but for this sway of the destructive philosophy of the eighteenth century, and of the Terrorists during the French Revolution, Pinel's blessed work would in all probability have been thwarted, and he himself excommunicated for heresy and driven from his position. Doubtless the same efforts would have been put forth against him which the Church, a little earlier, had put forth against inoculation as a remedy for small-pox; but, just at that time, the great churchmen had other things to think of besides crushing this particular heretic: they were too much occupied in keeping their own heads from the guillotine to give attention to what was passing in the head of Pinel. He was allowed to work in peace, and in a short time the reign of diabolism at Bicêtre was ended. What the exorcisms and fetiches and prayers and processions, and drinking of holy water, and ringing of bells, had been unable to accomplish during eighteen hundred years, he achieved in a few months. His method was simple: For the brutality and cruelty which had prevailed up to that time, he substituted kindness and gentleness. The possessed were taken out of their dungeons, given sunny rooms for habitation, and allowed the liberty of pleasant ground for exercise. Chains were thrown aside. At the same time the mental power of each patient was developed by its fitting exercise, and disease was met with remedies sanctioned by experiment, observation, and reason. Thus was gained one of the greatest, though one of the least known, triumphs of modern science and humanity.

The results obtained by Pinel had an instant effect, not only throughout France but throughout Europe: the news spread from hospital to hospital; at his death, Esquirol took up his work; and, in the place of the old training of judges, torturers, and executioners by theology to carry out its ideas in cruelty, there was now trained a school of physicians to develop science in this field and carry out its decrees in mercy.*

A similar evolution of better science and practice took place in England. In spite of the coldness, and even hostility, of the

* For the services of Tenon and his associates, and also for the work of Pinel, see especially Esquirol, "Des Maladies mentales," Paris, 1838, i, 35; and, for the general subject and the condition of the hospitals at this period, see Dagron, as above.

greater men in the Established Church, and notwithstanding the Scriptural demonstrations of Wesley that the majority of the insane were possessed of devils, the scientific method steadily gathered strength. In 1750 the condition of the insane began to attract especial attention; it was found that mad-houses were swayed by ideas utterly indefensible, and that the practices engendered by these ideas were monstrous. As a rule, the patients were immured in cells, and in many cases were chained to the walls; in others, flogging and starvation played leading parts, and in some cases the patients were killed. Naturally enough, John Howard declared in 1789 that he found in Constantinople a better insane asylum than the great St. Luke's Hospital in London. Well might he do so; for, ever since Caliph Omar had protected and encouraged the scientific investigation of insanity by Paul of Ægina, the Moslem treatment of the insane had been infinitely more merciful than the system universal throughout Christendom.*

But in 1792—the same year in which Pinel began his great work in France—William Tuke began a similar work in England. There seems to have been no connection between these two great reformers; each seems to have arrived at his results independently of the other, but the results arrived at were the same. So, too, in the main, were their methods; and in the little house of William Tuke, at York, began a better era for England.

The name which this little asylum received is a monument, both of the old reign of cruelty and of the new reign of humanity. Every old name for such an asylum had been made odious and repulsive by ages of misery. In a happy moment of inspiration Tuke's gentle Quaker wife suggested a new name; and, in accordance with this suggestion, the place became known as a "Retreat."

From the great body of influential classes in church and state Tuke received little aid. The influence of the theological spirit was shown when, in that same year, Dr. Pangster published his "Observations on Mental Disorders," and, after displaying much ignorance as to the causes and nature of insanity, summed up by saying piously, "Here our researches must stop, and we must declare that 'wonderful are the works of the Lord, and his ways past finding out.'" Such seemed to be the view of the Church at large; though the new "Retreat" was at one of the two great ecclesiastical centers of England, we hear of no aid or encouragement from the Archbishop of York or from his clergy. Nor was this the worst: the indirect influence of the theological habit of thought and ecclesiastical prestige was displayed in the "Edinburgh Review." That great organ of opinion, not content with merely attacking Tuke, poured contempt upon his work as well as

* See D. H. Tuke, as above, p. 110; also Trélat, as already cited.

on that of Pinel. A few of Tuke's brother and sister Quakers seem to have been his only reliance; and, in a letter regarding his efforts at that time, he says, "All men seem to desert me." *

In this atmosphere of English conservative opposition or indifference the work could not grow rapidly. As late as 1815 a member of Parliament stigmatized the insane asylums of England as the shame of the nation; and even as late as 1827, and in a few cases as late as 1850, there were revivals of the old absurdity and brutality. Down to a late period, in the hospitals of St. Luke and Bedlam, long rows of the insane were chained to the walls of the corridor. But Gardner at Lincoln, Donnelly at Hanwell, and a new school of practitioners in mental disease, took up the work of Tuke, and the victory in England was gained in practice as it had been previously gained in theory.

There need be no controversy regarding the comparative merits of these two benefactors of our race, Pinel and Tuke. They clearly did their thinking and their work independently of each other, and thereby each strengthened the other and benefited mankind. All that remains to be said is, that while France has paid high honors to Pinel, as to one who did much to free the world from one of its most cruel superstitions and to bring in a reign of humanity over a wide empire, England has as yet made no fitting commemoration of her great benefactor in this field. York Minster holds many tombs of men, of whom some were blessings to their fellow-beings, while some were parasites upon the body politic; yet, to this hour, that great temple has received no consecration by a monument to the man who did more to alleviate human misery than any other who has ever entered it.

But the place of these two men in history is secure. They stand with Grotius, Thomasius, and Beccaria—the men who, in modern times, have done most to prevent unmerited sorrow. They were not, indeed, called to suffer like their great compeers; they were not obliged to see their writings—among the most blessed gifts of God to man—condemned, as were those of Grotius and Beccaria by the Catholic Church, and those of Thomasius by a large section of the Protestant Church; they were not obliged to flee for their lives, as were Grotius and Thomasius; but their effort is none the less worthy. The French Revolution, indeed, saved Pinel, and the decay of English ecclesiasticism gave Tuke his opportunity. But their triumphs are none the less among the glories of our race; for they were the first acknowledged victors in a struggle of science for humanity which had lasted nearly two thousand years.

* See D. H. Tuke, as above, pp. 116–142, and 512; also the "Edinburgh Review" for April, 1803.

THE CHEMISTRY OF TO-DAY.

By IRA REMSEN,

PROFESSOR OF CHEMISTRY IN JOHNS HOPKINS UNIVERSITY.

SOME years ago, in the course of a conversation with an eminent mathematician, I asked in all seriousness whether he could give me a definition of mathematics that would convey to my mind even a faint idea of the object in view in mathematical investigation. He replied, "It is impossible to give such a definition—as impossible as it is in the case of chemistry." "But," said I, "I think I can give a definition of chemistry which would have some value"; and then, with little time to think, I suggested a definition, which elicited this remark: "I could certainly give an equally bald definition of mathematics." I have frequently thought of this subject since, and have wondered whether it is possible to convey to the minds of those who are not chemists a clear idea in regard to the work chemists are doing. The difficulties are great—as great, I suppose, as in the case of mathematics; for chemists are no longer engaged in the study of familiar phenomena, but are dealing with matters which lie far beyond the limits of ordinary observation. Still, I have thought it worth while to make the attempt, and it has seemed to me that I might accomplish my object best by calling attention to a few of the most important discoveries which have recently been made in the field of chemistry, and making such comments upon them as may serve to indicate what relations exist between these discoveries and the science as a whole.

Chemistry may be defined as that branch of science which has to deal with the changes in composition which the various forms of matter undergo. Not only has it to deal with these forms of matter, but also with the changes—that is, the acts involved in passing from one form to another. However bald this definition may appear to those who do not understand the subject, it is full of suggestion to the chemist. A chemist is sometimes spoken of as "one whose business it is to tell what things are made of." I accept this statement as expressing half the truth, but I attach to the words a much deeper meaning than they are intended to convey. To illustrate what I mean by this, let me take an example or two. Suppose a chemist is given a piece of marble. On examining it he finds without much difficulty that it is made of the forms of matter called carbon, oxygen, and calcium. He can also tell without much difficulty in what proportions these substances are present in the marble. He may thus tell what marble is made of. But is that all? May we not ask further what are the sub-

stances carbon, oxygen, and calcium made of? It is true we call them elements or simple substances, meaning by that substances which can not be converted into anything simpler. No matter what influences the so-called elements are subjected to, they can not at present be decomposed. When, therefore, a chemist, after examining any complex substance, is able to say what simple substances are in it, he tells what it is made of. But, I repeat, is his statement final? Is there nothing more to learn? Plainly the great questions still remain to be answered: What is an element? Are the forms of matter which we call elements absolutely independent of each other, or are they not in turn composed of still subtler forms of matter which we may hope to discover in the future?

While it is impossible to answer these questions at present, some discoveries have been made within the past few years which have a direct bearing upon them. It has been shown by a Russian chemist, Mendelejeff, and at the same time by a German, Lothar Meyer, that the elements are related in a very remarkable way, so closely that it is possible to arrange them all in one table, in which they form parts of a general system. The law governing the variations in properties of the elements is known as the *periodic law*. The limits of this article will not permit any detailed explanation of this remarkable law. The main point that I wish to emphasize is, that these so-called elements are shown to be related to one another, and it seems impossible, in the light of these facts, to believe that they are distinct forms of matter. It seems much more probable that they are in turn composed of subtler elements, and it has been pointed out that all the substances which we now call elements, of which there are about seventy, can be conceived to be made of two fundamental elements combined in different proportions. There does not, however, appear to be any immediate prospect of discovering these fundamental substances, though we can not, of course, tell what a day may bring forth. While the prospect in this direction is not promising, it appears clear that there are other elements of the same order as those now known yet to be discovered. When Mendelejeff first arranged the known elements in his table, he found that the table was not complete, and it became necessary to leave certain places vacant in order to secure a perfectly systematic arrangement. It was as if an incomplete skeleton of some great animal were found. On putting the parts together, the finder would discover that something is wanting to complete the whole, but nevertheless he would recognize the relations between the parts before him. He would also be able to tell what the general properties of the missing parts must be. So here, the discoverer of the periodic law recognized that the system was incomplete. He pointed out the gaps, and

prophesied the discovery of elements then unknown which would fill these gaps. Not only this, but he boldly ventured to describe some of these unknown elements in detail. At first no one was inclined to give serious consideration to the predictions; certainly no one dreamed that they would soon prove to be among the most brilliant predictions ever recorded in the annals of science. Within a few years all three of the elements predicted by Mendelejeff were discovered—the last one about two years ago. The first one was discovered in France, and was hence called gallium; the second, discovered in Norway, is known as scandium; and the third, recently discovered in Germany, is the baby element germanium. The descriptions given by Mendelejeff, eighteen years ago, are found to agree marvelously well with the facts. These discoveries have directed the attention of all chemists to the periodic law, and have lent a new interest to the discovery of new elements. There are undoubtedly others still undiscovered. Let us hope that the next one may come to light in the New World, and that we may thus have our own particular element, as France and Norway and Germany have theirs.

It is obvious from what I have already said that, to tell what things are made of, is not so simple a matter as it might at first appear. The best answer we can give, in any case, is lamentably incomplete. But there is another side to the subject, one of fascinating interest. Let me endeavor to illustrate this by means of another example. It has long been known that there are two substances, called respectively glucose and levulose, which are made of the same elements, viz., carbon, hydrogen, and oxygen, in exactly the same proportion by weight. Notwithstanding the fact that these two substances have exactly the same composition, they have markedly different properties. Chemistry abounds in similar examples. To account for these facts, chemists suppose that the parts of which the two substances are made up are arranged differently. An immense amount of work has been done during the past half-century with the object of reaching conclusions concerning what is called the *constitution of chemical compounds*, and the results reached in this field have been brilliant in the highest degree. By methods of the most refined character the chemist of to-day is enabled to enter into the innermost recesses of compounds, and trace out the connections which exist between the constituent parts. Many of the most complex compounds found in nature have thus been studied, their constitution determined, and methods have in many cases been devised by which the substances found in nature can be built up in the chemical laboratory without the intervention of the life process. Among recent achievements in this direction I may mention indigo. This is remarkably complex, and for a long time it had baffled all

efforts to determine its constitution; but, finally, that prince of experimenters, Baeyer, of Munich, succeeded, and indigo is to-day manufactured from inert matter; and, though this manufactured article can not yet successfully compete with that obtained from the plant, it is, in my opinion, simply a question of time when the occupation of the plant will be gone.

The subject of the constitution or structure of chemical compounds at present receives more attention from working chemists than any other, and this has been the case ever since chemistry came to be a science. Great progress has been made, particularly within the past twenty or thirty years. In this field, as in that of the elements, to which I have already referred, wonderful predictions have been made and verified. Let me here quote a passage from an address by that eminent physiologist and philosopher Emil Du Bois-Reymond. He says: "I know of no more astonishing production of the human mind than structural chemistry. To develop, from that which appears to the five senses as quality and transformation of matter, such a doctrine as that of the relations between the hydrocarbons, could scarcely have been easier than to develop the mechanics of the planetary system from the motion of luminous points; and Strecker's prediction of the synthesis of creatine, which was afterward verified by Volhard, although in a less exalted sphere, was in fact no smaller achievement than the discovery of Neptune."

Of late, attempts have been made to go still further into the subject of structure, and to get some clew as to what we may call the actual shape of the minutest particles of which all forms of matter are believed to be made up. According to the prevailing theory, every kind of matter is made up of certain minute particles called molecules, and these molecules are conceived to be made up of still smaller particles called atoms. This theory is not merely a wild suggestion of dreamers, but it is forced upon us after a profound study of an immense number of facts. It is found that the facts can be explained only on this assumption. In chemical compounds it is believed that the atoms of elements are united with one another to form the molecules, and that the compounds are made up of these molecules, which are moving around freely in the case of a gas, less so in a liquid, and held together in solids. Now, the problem of the chemist is to determine how the atoms are arranged in the molecule—or to determine what connections exist between the atoms, without reference to the actual arrangement in space. When we consider that the atoms and molecules are almost infinitely small—so small, indeed, that we are told that the smallest particle of matter visible with the help of a good microscope must contain from sixty to one hundred millions of molecules—it does seem in the highest degree presump-

tuous to make any statement in regard to the way in which the atoms are connected in the molecules. Yet this is just what the chemist of to-day does, and the results accomplished by working in the way referred to fully justify him. Let no one to whom the facts are unknown accuse him of indulging in useless speculation. Chemical hypotheses are for the use of chemists; and so long as they are helpful, so long as they lead to a clearer and clearer recognition of the great truths of our subject, so long as they lead us on to work, and the science grows in consequence, it is not pertinent to remark that there may possibly be a flaw somewhere. If there are flaws in chemical hypotheses, they will be recognized by chemists themselves sooner than by others. Let no one think that science has nothing to do with the realm beyond the senses. Without the aid of the imagination there could be no science. However important they are, facts alone could not constitute a science. It is necessary that the relations between these facts should be discerned, and this can not be done except by the aid of the imagination. There have been few bolder flights than those which pertain to matters of science. The greatest genius is he who sees furthest beyond the facts, and with the aid of his imagination is able to bring together into a harmonious whole those facts which seem least connected. But, it must be remembered, it is the imagination of the thoroughly trained mind, kept in subjection by profound knowledge, that leads to great results.

I have said that of late attempts have been made to learn something of the shape of molecules. Within a few months a remarkable paper, written by Prof. Wislicenus, of the University of Leipsic, has appeared, in which the actual arrangement of atoms in the molecules is seriously and brilliantly discussed. I can not even touch upon the contents of that paper. Suffice it to say that chemists generally are profoundly interested in the arguments of Wislicenus, and the subject is now under active discussion. To me it appears that the views put forward are well worthy of most serious consideration. What the outcome will be, none can predict; but, at all events, the fact is significant that chemistry has reached a stage when such a subject can be discussed.

Another subject which is coming to the front in chemistry is that which I had in mind at the beginning of this article when I said, "I accept this statement as expressing half the truth." It is unquestionably the chemist's business to tell what things are made of, but the other half of the truth is this: it is also his business to study the chemical act itself. In any given case he must not be satisfied when he has learned that when two substances, A and B, are brought together, they combine to form the new substance, A B. He must study that act of combination, and learn all he can about it. As these acts in most cases take place

almost instantaneously, this kind of study is exceedingly difficult. Nevertheless, some progress has been made within the last few years, and the number of chemists who are taking up work in this field is rapidly increasing. They are investigating such matters as the speed of chemical action, the influence of mass upon chemical reactions, and the relations between the phenomena of heat and electricity and chemical action. The best results have come from Russia, Sweden, and France. This branch is frequently referred to as physical chemistry. A number of books treating the subject have recently appeared, and a journal devoted exclusively to it has been started within the past year.

Now that I have begun to tell of the achievements of chemistry, I would fain continue; but, rather than run the risk of wearying my readers, I will turn at once to another subject, which I would gladly discuss at some length, but which I shall have to dismiss in a few words. I think I hear the remark: "This is all very well, but I thought chemistry was a practical science. What is the good of all these refined investigations on the nature of the elements and the constitution of chemical compounds? Can not the chemist find something more practical to work on?" These questions are constantly asked, and it is clear to me that they need answers. I take it that by the word practical is meant something which has a direct bearing upon our every-day lives. A practical investigation is one that leads to the establishment of some new industry, or it is one which leads to the discovery of some substance which can be used by man. My practical brother, then, has no sympathy with the kind of work I have been speaking of, but demands that the work should be of such character as to lead directly to results which can be utilized at once by mankind. It can not be denied that there is much that is reasonable in this demand. It is right that the results of scientific work should be made available, and that they should be utilized to the fullest extent for the improvement of man's condition. It is impossible to overestimate what we owe to chemistry, and we may confidently expect even greater gifts in the future than those which we have already received. Every year some new application of chemical discoveries is made. To whom do we owe the possibility of these applications? My answer is distinctly: We owe it to those chemists who are engaged in investigations in the field of pure science. Everything that tends to the perfection of the science of chemistry is of value in connection with the applications of chemical truths. The most refined investigation on the most abstruse chemical subject may furnish a link in a chain of argument—may be the one thing needed to lead to a most important generalization. The interests of the chemical industries and of the pure science of chemistry are identical. I do not ask that my

assertion be accepted as final evidence on this point. I ask attention to the important fact that the seat of the great new chemical industries of the world is that country in which the greatest attention is paid to pure chemistry. As the result of much experience in Germany, it has been found that those chemists who are best versed in the pure science are the best fitted to go into the great factories and conduct the chemical operations. Even in the technical schools in Germany the subject of chemistry is taught just as it is in the universities, in such a way as to give the student as much as possible of the pure science. If my practical brother could make a tour of the great laboratories of the world, whether in universities or in polytechnic schools, he would find that the subjects under investigation in ninety-nine out of a hundred of them are such as he would regard as in a high degree unpractical; and yet I say the experience of the world has shown that, where the most of this unpractical work is done, there the most practical results are reached. The testimony of chemists is unanimous on this point. We are therefore led to the conclusion that the most unpractical work is the most practical—a conclusion which I am sure will stand the test of the closest examination.

But I do not think that this last argument is needed to justify the abstract chemical work of which I have been speaking. Man can be improved in other ways than by ministering to his daily bodily needs. He has higher needs, and some of these are ministered to by enlarging the world of ideas. Every discovery is an addition to the world's stock of knowledge, and we are all gainers by these discoveries. The gain is not as tangible as the material ones, but it is none the less valuable. Is not the world better off for its books, its works of art? Take them away. Imagine the result! So it is with the results of scientific work. By the aid of this work we are advancing toward clearer conceptions of the universe and our position in it. Stop the work, and intellectual death must necessarily follow. The work must go on entirely independently of the question whether the results can be utilized at once or not. We need more light! Let us work for this.

PROF. LODGE, assuming that light is an electrical disturbance, reasons that all our present systems of making light artificially are wasteful and defective. We want only a particular range of oscillations, but to obtain them we have to produce all the inferior ones leading up to them. The force thus expended is thrown away. With his energy properly directed, a boy turning a handle could produce as much real light as we get with all our present expenditure. The waste is worse when we get light by combustion than with the electric lights, for then the air as well as the fuel is consumed, and the low heat-rays that are thrown out cause inconvenience as well as being wasteful. The light of glow-worms and of phosphorescence is produced without waste. We must learn to obtain light with equal economy.

GLASS-MAKING.

By C. HANFORD HENDERSON,

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I.—A PANE OF GLASS.

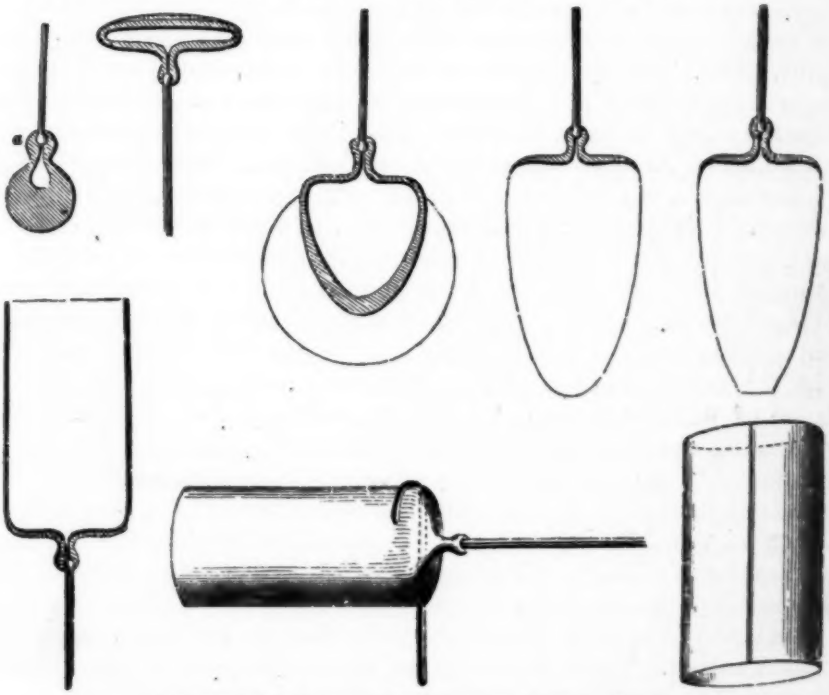
"O CARLYLE!" exclaimed Emerson, in his diary, at the time "Sartor Resartus" was being republished in America, "the merit of glass is not to be seen, but to be seen through; but every crystal and lamina of the Carlyle glass shows."

With admirable precision this defines the proper function of a pane of glass. Decorative art, in casting about for new fields of conquest, has too frequently induced a contrary feeling; but, after all, a window-pane at its best is something to be seen through and not to be seen. It is our means of looking out upon the world and letting the sun look in upon us. The more perfectly, then, it fulfills its function, the less evidence will it bear of its evolution from such dull things as sand and lime and soda-cake. Our window-pane is transparent in all things save its own history. It gives no hint of what it is made of, or how it is made. It is, indeed, easier to look through it than it is to look into it. If one look in the right direction, however—and in America this means toward Pittsburgh—he will see, in the cluster of glass-factories which have gravitated toward the natural gas of that neighborhood, a side of industrial activity possessing much interest. The brilliant pane of glass itself tells no stories, but the white-hot furnaces and pots of molten metal, the active, hurried figures, and the movements of rare dexterity that one sees at these places, are far more communicative.

They can well afford to publish their achievements, for about few of its material products can the nineteenth century boast with so much show of justice as about its window-glass. It is true that past ages have produced quite as remarkable technical results in other departments of industry, but in this one product, at least, the present decade appears to be unique. Not even China and Egypt, which have a standing claim of priority on all the arts and sciences, dispute with the modern glass-maker. His triumphs are without rival.

Contrary legends are afloat, but they can be chased into no fact. There is, for instance, a story current about the Queen of Sheba and the wise King Solomon that quite puts into the shade even the deceitfulness of riches. It is related by some gossipy chronicler that, at the time of the famous visit, the royal audience was so arranged that the queen and her suite in approaching were obliged to pass over a floor of glass under which were flowing

water and fishes swimming. For the legend has it that the wisest of men was decidedly curious. The Paul Prys of Jerusalem declared that the queenly visitor labored under the disadvantage of a deformed foot. The ingenuity of the monarch, it is said, suggested the device of the simulated stream, thinking that the lady's anxiety for her draperies would disclose to the court of Israel whether rumor had rightly reported her. But this performance is probably attributable to the imagination of one somewhat later than Solomon. It hardly sounds like the author of the "Proverbs," nor have we any record that the lady ever repaid



Successive Stages in the Manufacture of Sheet Glass.

him for his discourtesy—a bit of negative evidence that is almost conclusive. But at that time so inhospitable a scheme, even if seriously entertained, could scarcely have been carried out. The hundred and twenty talents of gold and the very great store of spices and precious stones, which to the queen's presence in Jerusalem added their tribute of admiration for wisdom, could not have purchased in any of the marts of the ancient world a plate of glass sufficiently large and sufficiently clear to have made such a deception possible.

The glass-blowers of the olden times undoubtedly produced some fine results in color, which can scarcely be equaled in the present. They had already attained, in the fabrication of rare

and curious forms, a considerable fame before the days of the Roman supremacy; but the magnificent sheet of glass through which we of a morning study the signs of the weather, or glance at the too tempting displays in the shop-windows, is a luxury which we must admit to be peculiar to our own times. It might gain for us the title of the "age of glass," had not the age already been devoted successively to the genius of iron, of steel, and of electricity.

There is also observable a marked difference in the spirit in which the earlier and the later artisans worked. While glass was still a product of some rarity, its manufacture naturally occupied a place among the fine arts rather than among the more common industries. The early glass-makers, in consequence, busied themselves more with the production of the costly and the beautiful than in any attempt to bring glass in its manifold applications within the reach of the poor. Later workers, on the other hand, have shown the influence of democratic institutions. They have found their greatest pleasure, as well as their greatest profit, in the production of wares of such utility and cheapness that their market includes even the very poorest. As a result of this enlarged production, the history of glass shows a marked increase in quality and a marked decrease in price. The interest aroused by this progress is not only technical and commercial, but, in the case of window-glass, in a still wider sense social and economic. In filling the windows of our houses with transparency, the glass-maker has been a public benefactor. His benefaction is the greater, since the material he supplies is now at the disposal of even those of limited means. We hardly appreciate the full significance of cheap window-glass. It lengthens the day to the dimensions assigned by Nature, and permits one to enjoy the sunshine of out-door life without exposure to the inclemencies of the weather. These are substantial contributions to the public health and well-being. At no previous time, we believe, could the dwellers in northern climes introduce into their homes so many square feet of sunlight for so little money.

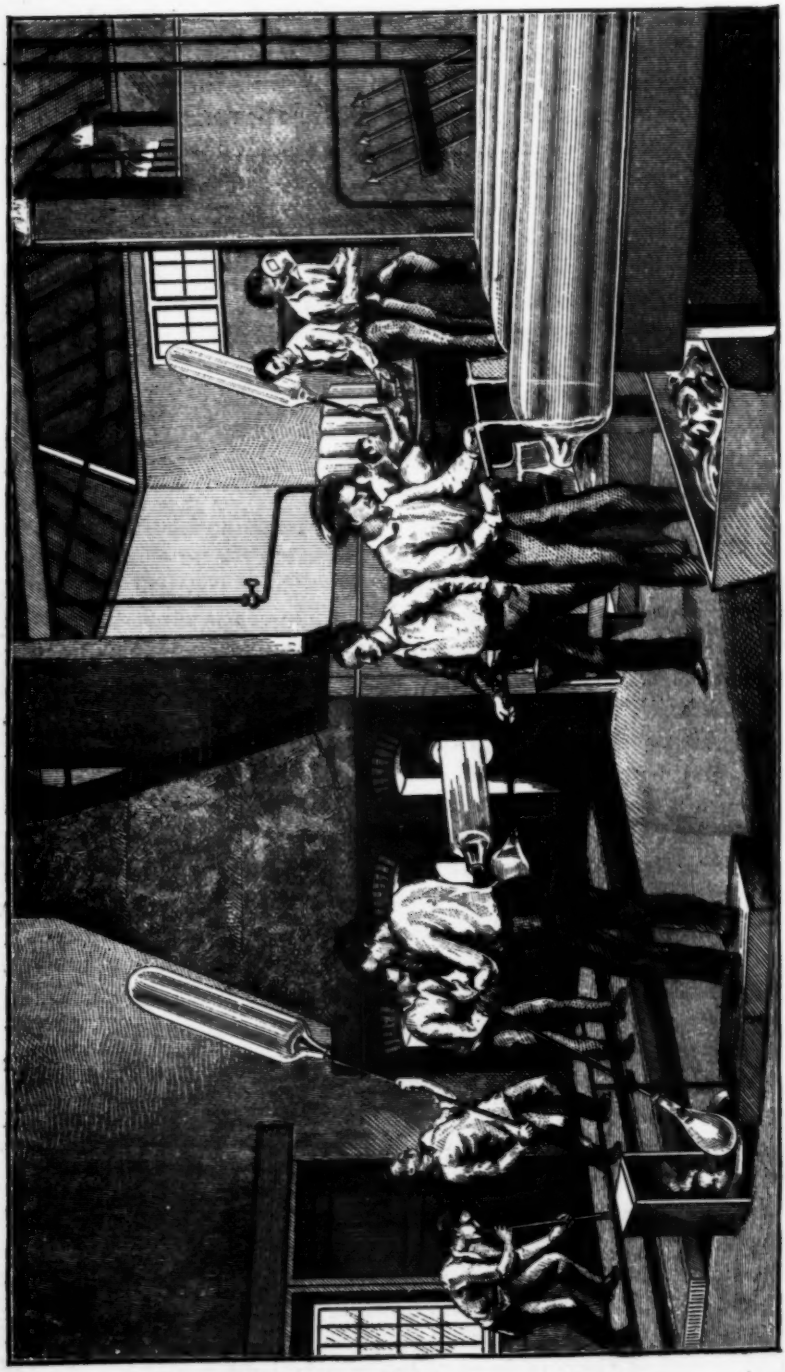
It is the purpose of the present article to offer a brief glimpse of some of the processes involved in the metamorphosis of the crude materials into a serviceable pane of glass. As the operations are actually carried out in the arts, the attention of the onlooker is constantly distracted by the flame and glare of the furnaces, the passing and repassing of red-hot glass, the clouds of steam, and puffs of dust and smoke. He comes away from the factory with an impression limited to the more spectacular features of the process. Of necessity he is quite oblivious of a hundred details of which it is very necessary that the glass-maker should be distinctly sensible. In making this visit by deputy, it

is proposed that little more shall be seen than falls to the lot of the flesh-and-blood visitor. It is, perhaps, wiser that the uncertain light and the steam and smoke shall be permitted to cover with their convenient mantle those technical details that would fail to attract general interest. In such matters it is uncomfortable to have your guide too knowing if he insists on sharing all his knowledge with you.

To define glass physically would be a superfluous task. Every one is informed of its hardness and solidity. A series of annoying accidents has demonstrated beyond doubt its exceeding brittleness. The ragged-edged splinters that result from such occasions suggest that the solid is amorphous, or without regular crystalline form.

To define the material chemically may be less unnecessary. It is a mixture of different silicates—that is to say, of mixtures of silicic acid with the bases soda, potash, lime, magnesia, alumina, iron, and lead. Considering that we are to be non-technical, this is rather a formidable list, but it must not be thought that any one glass contains all of these ingredients. Every true glass consists of at least two metallic bases united with the silicic acid, and generally, by virtue of the impurities of the crude material, traces of several more. So we have grown into the habit of designating the different kinds of glass by the names of the two predominant bases. Window glass, for instance, is known as a lime-soda glass; table crystal as a lead-potassium glass, and so on through the list. This system of nomenclature is open to the objection that the name of the product and its composition do not correspond in all the glass-producing countries, but these technical discrepancies seem unavoidable. The physical properties of the glass follow very closely its chemical constitution. Many of the silicates employed in glass-making are entirely infusible alone, but, when given suitable associates, are quite manageable. The weight of the glass is also directly dependent upon the metallic bases with which the silica is combined. Crystal is made heavy by the lead present, while window glass, having only light bases in its make-up, has a correspondingly small weight. It is little more than two and a half times as heavy as water. Each chemical change has its physical counterpart.

In spite, however, of the relative cheapness of glassware, we have still a pane of glass for the rich and another for the poor. Both products, the plate and the sheet glass, have essentially the same composition, but they differ very much in the purity of the crude materials used, and in the method of fabrication. Of recent years the improvements in the manufacture of sheet glass have been so marked that it is now frequently introduced into buildings of the better class in place of the more expensive plate. On



THE INTERIOR OF A SHEET-GLASS FACTORY.

the other hand, the processes of manufacture by which the latter glass is produced have been so far perfected that its use is now permitted to many who would hitherto have thought themselves unable to afford it.

A third form of window glass, the so-called crown glass, must also be mentioned for the sake of completeness, though it has little commercial importance, and less in America than in England. Both sheet and crown glass owe their origin to the blower's breath. Though they are less brilliant than the plate, their methods of fabrication are much more interesting, since they involve a far greater amount of manual dexterity on the part of the artisans. It is, indeed, difficult to know which to admire the more, the chemistry or the physics of the operation; the nicety with which the glass-maker regulates the proportions of his charge so as to produce this beautifully clear substance, or the skill with which he subsequently handles the finished glass and adapts it to our uses.

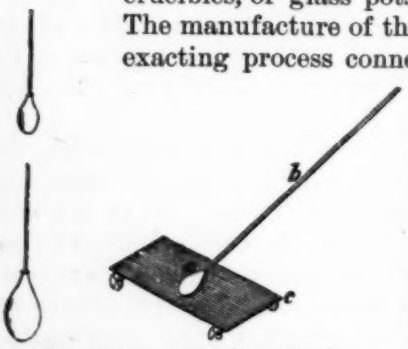
Sheet glass forms the window-pane of the multitude. The possibility of making it of excellent quality and in large sizes is due almost entirely to the substitution of gaseous for solid fuel. No other among our numerous American industries has been so benefited by the utilization of natural gas. European sheet glass was up to this time unquestionably superior to our own. A larger experience and more approved furnaces made it possible for the foreign manufacturers, and particularly those of France and Belgium, to solve with greater success the knotty problems connected with glass-making. In many places they had already substituted gas for coal, and obtained the happiest results. With the advent of natural gas the position of the American producer was suddenly changed. He had at his command the most desirable of fuels, and one that was at the same time very cheap and almost totally free from sulphur. As a result, he soon equaled and now surpasses his transatlantic rivals.

But the manufacture of window glass is essentially difficult. Even when the troublesome question of fuel has been satisfactorily settled, there remain many other substantial difficulties which must be met and conquered. From the mixing of the crude materials to the annealing of the finished product, the glass-maker must be alert and intelligent. It is a very easy matter simply to make glass. Sand, metallic bases, and heat are the only elements needed. But to make good glass—glass that is clear, transparent, colorless; that simulates the purest water of a mountain-stream—this requires skill and patience. From beginning to end the process is one of painstaking and delicate manipulation.

In the genesis of a pane of glass, the first step is naturally the provision of such stuff as it is made of. While glass is theoreti-

cally a definite chemical compound, the proportions in which the ingredients of the "batch" are mixed vary in every establishment. Sand is the basis of the operation. It is the commercial representative of silicic acid. With this are mixed lime and alkali (either carbonate or sulphate of soda, or both) in sufficient quantity to furnish an easily fusible mass that, on solidifying, shall be both clear and transparent. There is very wide range in the choice of materials. The purest grades have the disadvantage of costliness, while the inferior glass has the equal disadvantage of commanding but an indifferent price. Between these two considerations swings the balance of expediency.

When the batch has been made up, it is melted in large clay crucibles, or glass pots, as they are commonly called. The manufacture of the pots is the most tedious and exacting process connected with glass-making. It is one of the few industrial operations in which machinery has not been able to supersede man. A mixture of raw and burned fire-clay is employed. It is necessary that this should be prepared with the greatest care. Once a day for at least four weeks the mass must be turned and worked, in order to get it free from air and give it the proper toughness. For this kneading process no tool has been found equal to the bare foot. There are a warmth and an elasticity about it that better than anything else develop the required plasticity in the clay. Barefooted men, pacing up and down in lead-lined troughs, present a very primitive industrial picture. The impression is not removed when one goes up-stairs and watches the transformation of this much-worked material into crucibles. The hand here occupies the place that the foot does below-stairs. By equally slow stages the crucible is built up. First the bottom is formed, a circular slab about four inches thick and some forty inches in diameter; then the sides are gradually raised, a little addition being made each day, until at the end of about six weeks the work is completed, and a heavy, tub-shaped crucible is the result. Meanwhile the incompleted walls are kept constantly covered with damp cloths to prevent premature hardening. The temperature and humidity of the work-room are also objects of unremitting attention. But, though the crucible has now taken form, and its material been under treatment for more than ten weeks, it is not yet ready for the trial by fire. Several months must pass before it is considered sufficiently dried to withstand even a prelimi-



THE OPERATION OF "MARVERING."

nary heating. When the time comes, this is done very cautiously in a little furnace specially constructed for the purpose. Here the temperature is gradually raised to that of the melting furnace. The transfer from the one to the other is accomplished as rapidly as possible. The interior of the crucible is then glazed with a little molten glass, and the vessel is ready to lend itself to the transformation of the opaque into the transparent. After a variable term of servitude, whose length is totally unpredictable, the crucible finally succumbs to the combined attacks of heat and chemical action, and must be replaced by a fresh one.

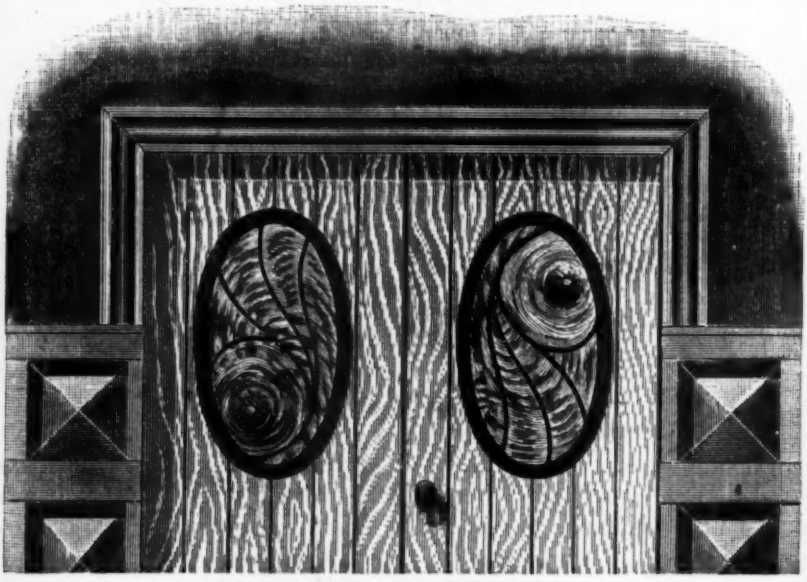
When gas is used as the fuel, the melting furnace is a very simple affair. It consists of a plain rectangular floor or hearth, which supports from eight to ten crucibles, two abreast. On each side of the furnace there is a series of round openings giving access to each pot. Arches at the end permit the admission of the fresh crucibles and the removal of the exhausted ones. The chimney is placed in the center, the gas being admitted at each end. The air necessary for combustion is first heated by passing through chambers in the base of the furnace. It will not be necessary to go into any further details of construction, for if one will simply imagine a white-hot apartment, perhaps forty feet long, eight feet wide, and six feet high, with ten crucibles of molten glass standing two abreast on the floor, and half as many openings on each side, he will have a sufficiently vivid picture of the melting furnace of a glass-factory. The batch is introduced into the crucibles in small quantities at a time, and then patiently coaxed into a proper degree of fluidity. When the last portion is added, a decolorizing agent goes with it, for, however pure the crude materials may be, there is always sufficient iron present to give the glass a greenish cast. Arsenic is a favorite bleaching agent. It acts by converting the iron into a higher oxide. In some establishments the peroxide of manganese is used for this purpose, but the least excess gives the glass a pinkish color, and it is also thought to make its transparency less durable.

Style dominates even so apparently an unmodifiable thing as window glass. Some years ago a slight excess of manganese was employed intentionally. It was thought that the mistress of the house—or her daughters—looked the prettier when seen through rose-colored window-panes. This decidedly pink glass may still be seen in not a few of the older houses in our Eastern cities. Its use is occasionally revived by some emergency.

This completes the chemistry of the process; the remaining operations are purely physical.

After the contents of the crucibles have become thoroughly fused, the temperature of the melting furnace is gradually reduced, so that the molten glass shall become less liquid, and thus

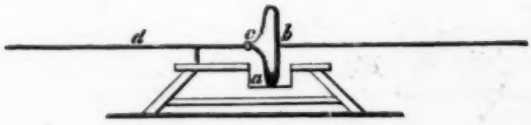
ready for the process of gathering. The impurities floating on the surface of the "metal" are first removed by skimming, much as the housewife does with her preserves. When the crucible was originally put into the furnace a fire-clay ring was placed in the bottom of it, and now floats on the bath. By removing all the scum from the interior of this ring the gatherer always has a clear surface from which to draw. The blow-pipe which he uses is simply a wrought-iron pipe about five feet long. It is provided at one end with a mouth-piece and wooden handle; the other end is thickened and somewhat flared, after the manner of a trumpet. This is dipped into the molten metal, and when withdrawn brings



CROWN GLASS IN DECORATIVE WORK.

with it a small lump of glass. By a dexterous turn of the pipe this plastic mass is formed into the shape of a symmetrical oval. The dipping process is several times repeated until a considerable mass of glass adheres to the end of the pipe. When window glass of double thickness is to be made, at least four or five gatherings are necessary. It is at the final dip that the gatherer's greatest skill is called into requisition. It is a pleasure to watch him as he seemingly toys with his blow-pipe. But each little movement is done with a purpose. The mass of glass on the end of his pipe is the result of successive gatherings, and must now be brought into a state of perfect homogeneity. To accomplish this, the last glass added is made to completely overlap the whole mass. The ball is then brought almost to a liquid condition, and seems ready to fall from the pipe. In less skillful hands, it would certainly come to grief. By a quick turn of the implement, however, the

gatherer throws the fold of glass into a spiral form, and so works it to the end of the mass. This leaves a perfectly clear and semi-plastic ball. The pipe is now withdrawn from the furnace and taken to an open wooden mold, or trough, where the glass is formed into a pear-shaped mass. The mold is kept constantly wet, to prevent its burning. The water, in contact with the red-hot glass, assumes the spheroidal condition, and looks like so many globules of mercury. The gatherer's duty is now at an end, and he returns to the melting furnace to repeat the operations of gathering until the crucibles are emptied of their contents. The blow-pipe and its red-hot burden, meanwhile, have been taken in charge by the blower.



ATTACHING THE "PONTY."

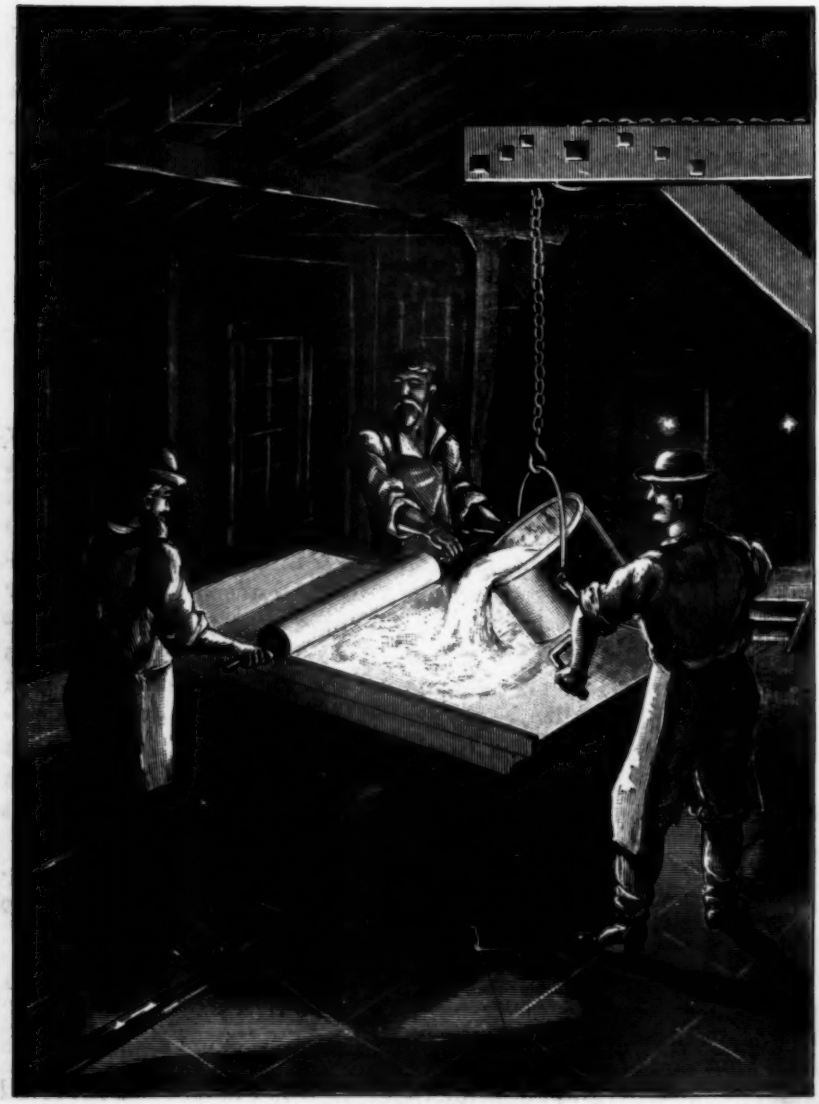
On the continent of Europe the same furnace is generally used for both melting and blowing, but in England and America it has been found more advantageous to employ separate furnaces. They are very similar in construction. The blowing furnaces have, however, somewhat larger side-openings, and the gas, instead of being introduced at the ends, is burned directly under the openings, or blow-holes. The furnace simply provides an intensely hot chamber for controlling the temperature of the glass under manipulation. On each side of the furnace, and directly in front of the blow-holes, there is a wide platform built over a cellar, or pit, perhaps ten feet deep. Long openings in this platform run at right angles to the furnace, and permit the blower, when occasion demands, to swing his pipe and its burden in the pit beneath.

The sheet-glass factories of Pittsburgh are equipped as thoroughly as any in the world. The division of labor is everywhere carried to the extreme. Each man knows how to do a particular thing, and does it. The blower, for instance, into whose hands the red-hot ball of glass has just been consigned, is supposed to know little or nothing about the other operations involved in glass-making. He begins at a certain point, and leaves off at a certain point. The skill with which he effects his part in the many transformations required in the genesis of a pane of glass is, however, the most attractive in a process nowhere devoid of interest.

FORMING THE "NOSE."

His first act is to grasp the pipe, and, with the ball of glass still resting in the wooden mold, blow through the mouth-piece

until a large bubble of air is formed in the midst of the mass; then, with alternate blowing and manipulating, he so increases the size of the bubble that the ball of glass assumes a shape not unlike that of the large carboys used in the transportation of



CASTING PLATE GLASS.

acids. He now transfers himself and his work to the platform in front of the furnace. Sometimes blowing, sometimes swinging his pipe in the pit beneath him, and sometimes reheating the glass in the blowing furnace in front of him, the blower gradually extends the dimensions of the bubble of air until the ungainly car-

boy, with its disproportionately thick bottom, has been replaced by a beautifully symmetrical figure, the shape of an enormous test-tube. But it occasionally happens that the glass flows a little too freely, and there is danger of the sides of the tube becoming too thin. To avoid this result, the blower throws his tube into the air whenever he finds that the glass is too liquid, and thus permits it to settle back upon itself. As the tube by this time is about five feet long, in addition to the length of the pipe itself, one can readily fancy that this apparently playful toss requires both skill and muscle. It is a fine sight to watch the graceful ease with which these brawny fellows accomplish it.

When the tube has been formed to the satisfaction of the blower—and it requires a surprisingly short time for the whole operation—he allows it to become comparatively cool. He then thrusts the rounded end into the furnace, blows into the mouth-piece of his pipe, and quickly covers the opening with his hand. Presently, a slight report is heard, like a mild explosion. The confined air, expanding with the increasing temperature, has blown a hole in the end of the softened tube. Resting his pipe on a convenient support, and still keeping the glass in the furnace, the blower gradually rotates the tube. Under the influence of centrifugal force, the hole grows larger and larger, until the tube becomes an open cylinder. It is then quickly withdrawn from the furnace and permitted to depend into the pit beneath the platform. When the plastic edge passes to a cherry heat, the cylinder may be taken away without danger of getting out of shape.

The blower's part is now finished. After a moment's rest, he has another pipe in his hand, and is repeating his heavy labor. His wages are considerably larger than the salary of many a learned professor or divine, but the service for which they are paid is of such a kind that it makes a man grow old very early. The severe muscular exertion, and the high temperature at which it is performed, are not conducive to either health or longevity. There may be exceptions, but as a rule there are few constitutions that can withstand for any length of time the quickly alternating heat and chills to which the glass-blower is daily subject.

The cylinder just laid aside is now cold. As soon as the neck and its attached blow-pipe are separated from it, a red-hot iron is passed along the interior surface from end to end. A piece of cold iron applied to any part of the heated line makes a complete longitudinal crack. We have now before us a perfect cylinder, open at both ends, and cracked from end to end. It has only to be ironed out into a flat sheet to be ready for service as a pane of glass.

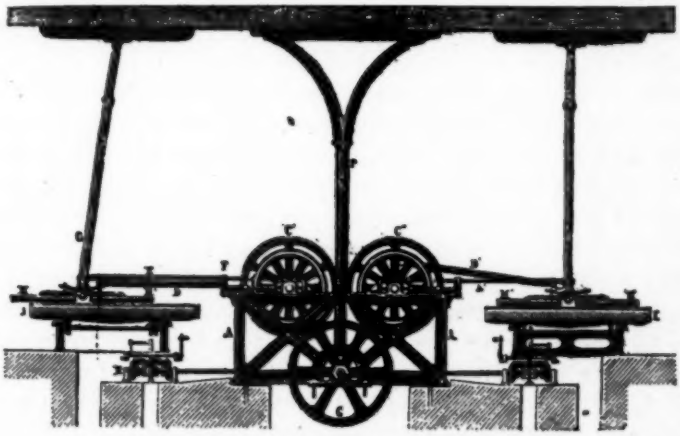
The ironing process is carried out in a separate building, in what is known as the laying-in furnace. The ease with which it

is accomplished is one of the triumphs of modern glass-making. In this department particularly, the merits of natural gas are each day more apparent. The hearth of the laying-in furnace is circular, and is divided into a number of sectors by fire-clay bridges. It is made movable about a vertical axis. As it rotates, the different sectors of the hearth pass through as many separate compartments of the furnace, the temperature of which may be varied at pleasure. The first compartment, the laying-in oven, is only moderately warm, and permits the glass cylinder to become gradually heated. It is then carried by a partial rotation of the hearth into the next compartment, the laying-out oven, where the heat is sufficient to make the glass plastic. A large, flat stone occupies each hearth-section and forms the ironing-board upon which the cylinders of glass are to be smoothed. In the laying-out oven, the crack in the cylinder is brought uppermost. Under the influence of the heat the glass gradually unfolds, until it lies open on the stone like a sheet of rumpled paper. In the succeeding compartment—the flattening oven—the plastic sheet is made perfectly smooth and flat by means of a moist block of wood on the end of a long iron rod. The cylinder has now disappeared, and in its place there is a pane of red-hot glass. One more turn of the hearth carries the glass into the compartment known as the dumb oven, where it gradually cools. It is then brought, by a final movement of the hearth, to the entrance of the annealing leer. One whole rotation has now been accomplished, and the circuit is complete. Meanwhile other cylinders have been put into the furnace and are in different stages of the flattening process.

The operation of the furnace is continuous, and speedily transforms the cylinder into a smooth sheet. But still it is not ready for use. Were the glass removed to the air immediately, it would be much too brittle for service. It must first go through the process of annealing, or gradual cooling, before it can possess any durability. In the improved "rod leer" the hot glass is received at one end of a long brick chamber, and in thirty or forty minutes it is automatically discharged at the other end, nearly or quite cold. Where gas is used, the glass, just as it comes from the leer, is beautifully clear and brilliant. It could scarcely be more so had it been washed with hot water and dried with linen —the process, we believe, by which madam, our hostess, secures such a glittering display on her table. The sheets are at once cut into proper sizes and stored away in suitable wooden frames. The process of manufacture is completed, and only the service of the glazier is needed to put the pane in place, and so inaugurate its luminous mission.

Strange fancies attend the visitor as he wanders through the silent warehouse. He loses himself amid the possible pictures

which these window-panes are destined to confront. Perhaps the old fable of the wind and the sun comes back to him. The cloak that the one in all its fury could not tear off is gladly thrown aside when the other exerts its power. The same with our pane of glass. It is to repel the rougher storms and winds, yielding passage only to the gentler elements. Sunshine and moonlight are to filter through it, and back of it pleasant fireside pictures are to group themselves. But the imagination is not always so obliging; darker possibilities obtrude themselves as well. The shuddering forms of want and wretchedness are also there, and the solitary dreamer is glad to turn away from them all, and pass out of the open door back again into the world of reality.



ROTARY GRINDING MACHINE FOR PLATE GLASS.

The manufacture of crown glass possesses considerable historical interest, but little beyond that. Within the past few years it has been brought into some prominence again from its growing use in decorative windows. It possesses, it is true, a brilliancy much superior to that of sheet glass, but the small size and unequal thickness of the pane obtainable do not permit it to compete successfully with the generous dimensions and remarkable uniformity of the glass now dominant. In mode of fabrication the crown glass proceeds precisely as the sheet up to the time of blowing; at this point the two processes diverge. The ball of semi-plastic glass on the end of the blow-pipe is fashioned into the shape of a cone, as the result of successive rollings on a table of metal or stone, known as the "marver." The process itself goes under the name of "marvering." The apex of the cone forms the so-called "bullion-point." By blowing into the mouth-piece of his pipe, the blower expands the glass into a small globe. This is subsequently enlarged, care being taken that the bullion-point is always kept in line with the pipe. The globe of glass is then

flattened into something the shape of an enormous decanter. The bottom is very flat, and has the bullion-point exactly in the center. The pipe and its ungainly burden are now permitted to rest horizontally on two iron supports. In the mean time a second workman has gathered a small lump of glass on the end of his iron rod, or "ponty," and by pressing it against an iron point forms it into the shape of a tiny cup. This is fitted over the bullion-point of the glass, and, as they are both hot, soon becomes firmly attached to it. The glass has now two handles, but one of these, the blow-pipe, is speedily separated from it by means of a sharp blow. The open neck which is thus exposed is known, in the glass-maker's parlance, as the "nose." It gives its name to the furnace where it is subsequently reheated. During this operation the ponty is constantly and rapidly revolved. The nose gradually expands under the combined action of heat and centrifugal force. The opening grows larger and larger until the glass assumes the shape of a typical crown. This appearance, however, remains but an instant. One sees in its place a brilliant circular plate of glass whose shape is only maintained by continuing the rotation of the ponty until the plate, or table, as it is now called, can be placed upon a flat support. The ponty is then detached from the bullion-point by means of shears. The mark that is left is known as the bull's-eye. The tables vary in size from a few inches in diameter up to six feet, but this latter dimension is extreme. After annealing they are cut into panes by means of a diamond. The loss involved in the operation more than counterbalances the admirable brilliancy of the material. At the present time, the circular tables, just as they come from the annealing oven, are being used in decorative windows with the most excellent effect. Frequently the glass is tinted, or else it is left colorless itself, and the bull's-eye is either shaded or opalescent.

The window-pane of the rich is commonly plate glass. Of the three varieties, this is by far the most desirable in everything except, it must be added, the price. Though similar in composition to the sheet and the crown glass, its fabrication is carried out upon a totally different principle. Instead of being, like them, the result of the blower's breath, the plate glass is cast into a flat sheet and then ground and polished, a process of manufacture which at once accounts for its expensiveness. The best practice to be seen anywhere in America, if not in the world, is at Creighton, some twenty miles north of Pittsburgh. It is near the well-known natural-gas district of Tarentum. There are a number of large establishments in this country where plate glass is manufactured, but the Creighton plant enjoys the reputation of possessing the most favorable economic conditions as well as the best equipment.

In the selection of the crude materials great care is taken to secure purity. The melting is carried out in large, open pots, the furnaces differing in their construction from those already described only in their greater size, and in the substitution of iron doors lined with tiles for the customary gathering-holes. When the melting is completed, the door nearest the pot to be emptied is opened, and a two-pronged fork, mounted on wheels, is inserted into the furnace. The prongs fit into depressions in the sides of the melting-pot, and thus secure it in a firm grasp. The pot of molten metal is then removed from the furnace and carried on a low truck to the casting table. At Creighton, the casting house, containing furnaces, tables, and annealing ovens, is 650 by 160 feet, about four times as large as the famous *halle* of Saint-Gobain in France, and nearly double the size of the British casting house at Ravenshead. The capacity of the American works has recently been greatly increased, and several new plants established in different sections of the natural-gas territory. The casting tables, the most important pieces of apparatus in a plate-glass works, are nineteen feet long, fourteen feet wide, and seven inches thick. Each is provided with an iron roller, thirty inches in diameter and fifteen feet long. Strips of iron on each side of the table afford a bearing for the rollers and determine the thickness of the plate of glass to be cast. The rough plate is commonly nine sixteenths of an inch in thickness; after polishing, it is reduced to six or seven sixteenths. The casting tables are mounted on wheels and run on a track that reaches every furnace and annealing oven in the building. The table having been wheeled as near as possible to the melting furnace, the pot of molten glass is lifted by means of a crane, and its contents quickly poured on the table. The heavy iron roller is then passed from end to end, spreading the glass into a layer of uniform thickness. The whole operation of casting scarcely occupies more time than it takes to describe it. Each movement is made with almost nervous rapidity. Few industries offer such fine scenic display as the pouring of the molten glass. One feels like crying *Encore!* it is so very brilliant.

In contact with the cold metal of the table, the glass cools rapidly. As soon as possible, the door of the annealing oven is opened, and the plate of glass introduced. The floor of the oven is on the same level as the casting table, so that the transfer can be conveniently and quickly made. When, after several days, the glass is taken out of the oven, its surface is found to be decidedly rough and uneven. A small quantity is used in this condition for sky-lights and other purposes where strength is required without transparency. It is known in the market as rough plate. The greater part of the glass, however, is ground, smoothed, and polished before it leaves the establishment. The work of the "hall

men" ends with the production of the rough plate. Its next guardians bear the name of "grinders." These confer upon the glass the property of transparency. The grinding is accomplished by means of rotary grinding machines, the abrading material being common river-sand, dredged from the Alleghany. Several million bushels are annually required for this purpose. The plates are firmly fixed on rotary platforms by means of plaster of Paris, and rotating disks are so arranged that they cover the entire surface of the plate at each rotation of the platform. Small jets of water keep the grinding-sand constantly wet. But such treatment only removes the rough exterior; the smoothing is accomplished by means of emery, finer and finer grades being used as the process proceeds. The final polish is given by means of rouge (carefully calcined sulphate of iron), which leaves the glass perfectly smooth and ready for use.

Many doubtless remember the time—not so very long distant—when such a thing as American plate glass was totally unknown. It all came from France. But we have discovered—much to our satisfaction—that quite as good plate glass can be made at home as can be brought from across the water. Some, not as cautious as ourselves, say that the home product is the superior. Certainly the demand for it increases about as rapidly as new factories can be built to supply it. The joint product of the two Creighton plants is nearly two hundred and fifty thousand square feet per month, or about seventy acres of plate glass a year! It takes some eleven hundred hands to turn out such a product as this, and its value is reckoned in the hundred thousands. Natural gas is used everywhere throughout both works, displacing, perhaps six thousand bushels of coal daily. Among other duties, it supplies steam for engines of probably not less than three thousand aggregate horse-power. The new factory, some miles to the east of Creighton, will have a capacity, when completed, of three hundred thousand square feet of glass a month. We should hesitate to introduce so many figures, remembering the general aversion to statistics; but they will present, better than anything else, a just conception of the magnitude of the operations connected with a large factory, and will perhaps dispel the notion—if such exist—that we are still largely dependent upon French dexterity for our supply of plate glass.

Such, in brief, is an outline of the three processes by which a pane of glass may be produced. Each day it becomes more perfect, until now there seems little further to hope for, unless it be that the glass might lose some of its readiness to break into pieces on the least provocation. Our windows are already as large as we care to have them, and so clear that, every once in a while, some unlucky soul ignores the fact that the window has any glass in it.

Such flattery as this encourages the glass-maker, in a double sense, to renew his efforts. It assures him of a continued demand, and also that his window-pane has fulfilled its highest function—in having been seen through, without being seen.

SOUTH SLAVIC MOON-MYTHS.

By Dr. FRIEDRICH S. KRAUSS.

THE South Slavic peoples have a number of popular songs reciting with many variations the theme of the wedding of the sun or the moon with the morning star or dawn. The relatives of these luminaries also play a part in the wedding processions, and appear variously as the nuptial dignitaries—Saint John, the thunderer Elias, and the holy Virgin Mary. The story runs along so plausibly that one can not tell by reasoning what is signified by the invocation of these higher beings; in other words, with all its clearness it is quite obscure. But the learned mythologist easily does away with all difficulties, and applies his artificial explanations with the greatest satisfaction. Parallels are easily drawn from Grecian, Roman, Indian, Germanic, or Lithuanian mythology, and the thing is done. The stereotyped conclusion of the mythologists is drawn to the effect that a people that entertains such speculations must have formerly had a high degree of culture, and have been of equal birth with the oldest civilized nations.

The answer to such talk is, that the stories of these sun and moon weddings have no support in the faith of the people, and are in no wise consonant with their other national and religious notions. Certain fables are indeed appealed to, that tell how the youth, in search of his ever-vanishing love, inquires in turn of the wind-mother, the sun-mother, and the moon-mother. But, to accept these in explanation, we have to pass off as specifically Slavic what is really and confessedly an all-world story, and in which there is, therefore, nothing significant of the South Slavic superstition.

It is not necessary to believe that there is any illusion in the matter. While the popular thinking is often illogical and takes poetry for truth, real misapprehension exists only among individuals, and the popular mind takes a fixed direction. Examination of the songs in which these moon-marriages are mentioned will show that they are exclusively lyrics or short songs, such as are sung by the processions at the bringing of the bride from the parental home, or which greet her as she enters the house of her spouse. The significance of the part played in them by the stars is explained by the popular custom of giving to the wedding-guests,

particularly to those who have anything to do with the ceremonies, pet names by which they are called till the affair is over. A stereotyped name for the bride is Danica (the morning star), and for the groom Sunce (the sun) or Mjesec (the moon). The principal groomsman is addressed as Saint John; the god-father as Elias; the first bridesmaid as Mary; and the other guests usually receive names of flowers. The three chief personages after the bridal pair have generally the stereotyped name and a newly borrowed pet name. Evidently a poetical expression rules in these affairs, by which the figurative characterizations of the higher spheres of the sky have been adapted to the transferred names. Among the more than a hundred songs of this kind we cite one from B. Petranovic's collection of Servian popular songs, which relates how the suitor wakened the passion of his sweetheart:

"The morning star said angrily to the moon,
Where have you tarried, my bright moon, so long?
Where have you tarried, where have you idled the time?
Where I tarried I idled no time:
We were eating for you a supper of sweets;
We saw for you a maid as handsome as pearl;
Her hair was fragrant with sweet-smelling blossoms—
Oh, would that the flowers were for me!
Then jealous anger possessed the morning star,
And she speeded in rage over the clear sky."

The poetic imagery is, I think, perfectly comprehensible. It is of common application in popular verse. Let us recollect that every literature of the kind has only a comparatively limited stock of comparisons and figures, and that it is, therefore, obliged to make a narrow means suffice for all occasions. It does not readily waste its poetical material, and it is turned from its course only when the occasion is an extraordinary one. Metaphors drawn from the stars are still in full vigor, but find their complete adaptation only in poetry. But there is not a trace of mythological mysticism in it.

It may be observed, in explanation of the popular faith about the moon, that the people regard its regularly recurring decrease and increase wholly according to the apparently good or ill working of its phases upon the fortunes of man and the world. Of the phenomena themselves they have no settled opinion, although some incline to accept a fable which is peculiar to the Croats on the Steiermark border as a popular myth. I prefer to regard it as a part of the apocryphal folk-lore of the middle ages, or perhaps as of German origin. Saint Elias, as the national saint, lord of the highest mountains, lends it his name only to save the trivial story from ridicule. It runs:

The holy Elias once had a long leisure-spell, and went out

walking. Coming to a small bay, he sat down and rested there for three days, till, getting hungry, he began to catch crabs and eat them. He relished them so well as to eat up nearly all there were. But God would not let this come to pass, and therefore raised a great wind that took the saint up into the air. He traveled through space for three days, and reached the moon in the night. Here the saint was punished by having to look down into the sea all the night long and see the crabs grow. Then so great hunger came upon Elias that he bit off piece after piece from the moon and swallowed them; and if God the Lord had not been gracious enough to order the moon to increase, the saint would have died of hunger after eating it, and have fallen to the earth and been broken into a thousand pieces. Yet God spared him and transplanted him to the moon; else he would have eaten up all the crabs in the sea, and at another time would have had only empty disappointment. Thus the moon decreases and increases according as the saint eats or fasts.

If we divest the fable of its unessentials, which may be set to the account of some unknown poet, there is left a feature of international folk-lore, viz., that sins have to be expiated in the moon. As in German superstition, so also in that of the South Slavs, the man in the moon is a desecrator of the holy Sabbath rest. Sometimes he is a wood-cutter, sometimes a blacksmith. The story reads that a wood-cutter, having stolen some wood in the forest on Sunday, was condemned to be a wood-destroyer in the moon for all eternity. He can be seen at full moon, sometimes with an axe in his hand, sometimes with a bundle of sticks on his back.

Another version tells that there was once a blacksmith who knew how to make skeleton keys with which one could open any lock, and, because he did this on Sundays and holidays, was condemned to work forever in the moon. It may be in deference to the conception of the ghost of Frau Mictlwoch, who was punished for desecrating a holy day by spinning, that a spinner is sometimes substituted for a man in the moon. The Swabians also find a spinner there.

A maiden was accustomed to spin late on Saturday in the moonlight. At one time the new moon on the eve of Sunday drew her up to itself, and since then she has sat in the moon and spun. And now, when the "gossamer days" set in late in the summer, the white threads float around in the air. These threads are the spinnings of the lunar spinner.

The moon is especially a weird avenger of human arrogance, and has its humors, according to which things go well or ill with it. In its waxing it has a special force and a certain good-will for the earth and its inhabitants, while in its wane it is friendly

to no one. The good woman must not do any sewing in the decrease of the moon, for the stitches will not hold; farming-tools must not be left in the field, because, it is believed, if they are, crops will not again thrive there. If an unbaptized child is exposed to the moonlight, it will lose its luck for its whole life. If one points at the moon with the finger he will suffer from swellings around the nail; and whoever spits at the moon will lose all his teeth. These beliefs, too, are international. The same is the case with the religious notions about the new moon. Sorceries of every kind, to be successful, must be performed on Sunday night of the new moon. The hair must be cut only in the increase of the moon, otherwise there is danger of getting headache. If a person returning home in the evening sees the full moon, he ought to take some money out of his purse, and utter an incantation that will make it increase a hundred times during the month.

The moon is also supposed to have an influence over animals and plants. Cucumbers become very large by lying three nights in moonshine. Trees, of which it is intended to make timber for a house, must be felled only in the full moon, else some one in the family will die very soon. Sheep must be sheared in the increase of the moon, for the wool is then longest and most durable. Swine should be slaughtered at the same season, when they are at their fattest and in the most healthy condition.

What Tacitus says of the Germans, that they believe that certain things are best undertaken in the new moon or before its full, is also applicable to the South Slavic superstitions. In both German and South Slavic popular lore, the moon is only a fetich, and South Slavic belief at least affords no ground for the supposition that it is honored as a divinity; and I have no hesitation in declaring that the finely drawn speculations of Slavic mythologists respecting the moon are only learned but vain dreams.

We may remark, in conclusion, that peasants are wont to predict the approaching phases of the weather from the color of the moon. They have the belief that the moon is like a sponge, and can instantly absorb the clouds, and as quickly let them loose again to darken the sky. If the moon shines silvery clear, fine weather is at hand; if it looks reddish, there will be wind; and a pale moon is a sign of impending rain. Some believe that if the horn of the new moon shows a little spot, the weather at full moon will be foul; if there is no spot, it will be fair till the end of the month.—*Translated for the Popular Science Monthly from Das Ausland.*

PROF. NEHRING believes that the dog is descended from various still-surviving species of wolves and jackals. It is not particularly difficult, he says, to tame jackals, and many attempts to domesticate wolves have been made in recent times.

COMPETITION AND THE TRUSTS.

By GEORGE ILES.

LAST autumn I happened to spend a few days in the heart of the Adirondacks, in a small village some fourteen miles from the nearest railroad-station. During the stage-coach journey I found that two of my fellow-passengers were commercial travelers. It was somewhat surprising to find them invading so remote an outpost of civilization, a hamlet at best, both expensive and troublesome of access. During my stay there, scarcely a day passed that did not bring the shop-keepers a traveling salesman from Albany, Boston, or New York. About a month before my visit, the principal merchant in the one straggling street of the place had been called upon one morning by no fewer than four solicitors of his trade. Could there be any better illustration of modern commercial competition than this penetration of the wilderness of northern New York by men who brought to the tents and cottages of a minor health-resort the latest fashions in dry-goods and millinery, the most recent products of mill, refinery, and cannery, romances fresh from the press? And, conjoined with the very palpable benefits of competitive enterprise, were not its wastes and burdens as clearly exemplified? While that far-away village was much advantaged by the keen rivalry to supply its wants, the efforts to secure its business were certainly not adequately repaid.

Fifty years ago so small a village, instead of several stores, would have had but one or two; their stocks chiefly bought from local makers of cloth, plows, stoves, and wooden-ware. Near by we would have had a shoemaker's shop, and perhaps, if the place were not too small, a tailor's as well. Twice a year the country store-keeper would go to the nearest large trade-center, New York, St. Louis, or New Orleans, and buy goods enough for the entire business of six months. Railroads and the development of steam manufacturing have changed all this. Small local cloth-weavers, stove-founders, and so on, have disappeared, for production is no longer profitable unless conducted on a vast scale. A cotton-mill now employs a thousand operatives instead of a hundred, while to build, equip, and launch a modern foundry demands the capital of a millionaire. The price of a staple article such as paper is now quoted to hundredths of a cent, and so slender have profit-margins become that in certain gigantic industries they consist solely in what a generation ago were deemed waste products. Many Northwestern flour-mills now find their dividend in the bran which used to be thrown away. From cotton-seed, until

recent years accounted worthless, does the Southern planter derive a goodly proportion of his gains; and while increase of magnitude in industrial concerns tends to minimize the cost of management and to promote the economies due to the division of labor, we see a constantly growing specialization of industry. A few years ago combs formed part of a general variety of goods turned out by an India-rubber factory; now two large concerns exclusively devoted to comb-manufacture supply nearly the whole American demand. Immense factories of wooden-ware and tin-ware, fitted up with costly and ingenious machinery, have obliterated the small local shops which used to flourish a generation ago, and custom shoemakers and tailors are suffering from the constant encroachments of manufacturers whose wares are made wholesale at the lowest limit of cost. Low prices, due to cheapened production, have created large new home markets, as, for example, in the inexpensive pianos and reed-organs to be found to-day in the homes of all but the poorest.

Every commercial traveler's trim sample-case bears witness to the progress of a hundred arts and sciences employed to increase the supply of a luxury, to make articles of every-day use better and cheaper. Every can of peaches, every quire of paper, every yard of cassimere, testifies to some new achievement of ingenuity and skill. Does some alert mind in the great army of those who earn by serving devise some new and better way of manufacture, transportation, distribution? Rivalry quickly imitates it throughout the length and breadth of the land, to the general profit. In this unceasing economization of human effort the railroads have borne a leading part. Markets no longer mean those furnished by groups of States; the whole Union is now opened up to the enterprising manufacturer, no matter where he establishes himself; and the steadily decreasing freight-tariffs of the railroads are due not only to the growth of their business and to applied science in the details of construction and operation, but also to the economy which attends the unification of great systems. A closely printed page scarcely suffices to enumerate the lines operated by the Pennsylvania Company. From Vancouver to Montreal, a single management extends for twenty-nine hundred miles, and will soon, in reaching the Atlantic seaboard, span the continent.

The benefits of competition in manufacture and trade are so many and conspicuous that its losses and burdens are very apt to be disregarded; yet they are neither few nor insignificant. One class of them is the creature of steam, which, applied within recent decades to transportation and manufacture, has in the main been so great a source of public advantage. Forty or fifty years ago a weaver made cloth and a shoemaker boots for customers within a short distance of loom or shop, so that they could pretty

accurately adjust supply to demand, and their shelves were rarely too heavily laden with wares. To-day, so rapidly have improvements in steam-machinery multiplied the output of factories and mills, that overproduction is their chronic case; and this overproduction is in no slight measure due to a fallacy into which sanguine men have been led by the rapid expansion of America's railroad system. Beyond the increase of market due to new populations attracted by this expansion, unwarranted expectations have been entertained. The mere aggregation of the small districts in which business was done in the past has been taken to mean an immense enlargement of the whole national demand, as if taking down fences were to augment the area of contiguous farms. Railroad extension means new rivalry quite as often as new customers. Woolens woven in Minnesota now compete in Massachusetts and Connecticut with goods of home production. Iron castings from Tennessee and Alabama are to-day entering Northern markets by virtue of freight-tariffs nominal in comparison with those of fifteen or twenty years ago. Now that the whole Union is merged as a single market, calculations with regard to competition are more difficult than ever before. A generation or two since under-supply was a common liability. To-day the opposite embarrassment of overproduction is the business man's problem as he surveys dislocations of industry as much more severe than those of his grandfather's time as the waves of the storm-beaten Atlantic exceed the ripples of a mill-pond. And evil has bred after its kind. Prior to 1878 Canada had a low tariff; the protective duties enacted that year were imposed chiefly because of overproduction in the United States. It was shown that Canadian manufacturing interests were demoralized through the Dominion being made a slaughter-market for the surplus stocks of American factories and mills.

Competition's systematic underselling is chargeable with the enormous losses which arise from adulteration. Consumers are usually poor judges of the purity or durability of what they buy, and the appearance of cheapness easily deceives them. When once adulteration has lowered a price, they resist the increase of it necessary to restore a sound standard of quality. Yet, as a rule, the great majority of those who practice adulteration are unwilling parties thereto. If a grinder of paints begins mixing sulphate of baryta with his white leads, his competitors must do the same. If a dealer in sirup dilutes it with glucose, in self-defense others in the trade must practice the same deception. The low prices brought about by such methods mean dear buying. Especially is this the case with textile fabrics. Cottons and woolens are not seldom deteriorated in wearing quality one half by admixtures which only reduce the cost of production one fifth; and greed has

not hesitated to dilute and falsify the drugs employed to assuage pain and heal the sick and wounded. With this not only the intensity of modern competition but the width of its area has had something to do. One of the strongest moral checks in human nature is sympathy with suffering; but if aggravation of suffering be remote in place, uncertain in time, and unpublished, conscience is apt to slumber. A druggist to-day receives from scores of factories hundreds of preparations, concerning the purity of which he knows little or nothing. He dispenses them not to neighbors, but to customers, who, from the necessities of the case, must be strangers to him.

Not only in adulteration, but in other evils developed by competition, is the meanest man in a trade the lawgiver in that trade. A manufacturer or miner imports cheap Italian and Hungarian labor, thereby reducing the standard of living among his other work-people to the Italian and Hungarian level, and obliging his competitors to follow his example. A few firms who introduced child-labor into the manufacture of garments are responsible for the shrinkage in wages which of late years has steadily overtaken the entire seamstress class.

Adam Smith tells us that one of the elements of price is the higgling of the market—a pregnant observation concerning one of the grievous burdens of competition. We hear much about the frauds perpetrated by those who make and sell goods—we hear little concerning the frauds committed by those who buy; yet buyers and sellers are made of the same clay, and buyers not seldom grudge to pay a fair profit to the men who supply them. To illustrate: Let us suppose the firm of Robinson & Co. to be makers of thermometers, on which they set prices as just to their customers as to themselves. They are accustomed to sell a tenth part of their output to a certain New-Yorker. He goes to them one day and says that, unless they reduce their prices five per cent, he will cease to deal with them. Although at a deduction from the profit fairly their due, they comply, simply because to refuse will result in larger loss than to submit. What one customer has done others may do, so that "higgling" may for a longer or shorter time force capable and industrious men to work without wages. Competition may be dreaded for just as well as for interested motives. A new rival may inflict severe loss through overestimating the business field which he enters; through cutting the price of a staple below cost, and making it what is called a "leader"; or through downright dishonesty and recklessness.

One of the remarkable developments of modern competition is in the matter of its costly and pervasive methods of solicitation. This, in the case of the commercial-traveling system, has had

effects good and evil. While it brings the latest products of metropolitan taste and skill to the remotest and smallest settlements, its services, when ignorantly and chancefully directed, as in the case of the Adirondack village, result in waste and loss. An agent of shrewdness and fidelity can exercise a very valuable watchfulness over his principal's debtors, yet a system which tends to make a "connection" the property of an agent, transferable to a new employer, is not one to diminish the liabilities and cares of business management. But the chief evil of the oversolicitation which is so common is the undue cheapening of credit. While it continues to be as difficult as ever for a merchant to borrow money, there is nothing easier than his getting credit for money's worth in the form of goods. Whereas an old-time shop-keeper, in his face-to-face transactions with a wholesale merchant or manufacturer, explained why he deserved credit when he wanted it, nowadays persuading people to take credit, even for what they do not want and may not pay for, has become a fine art; while the investigation of the creditability of firms is the function of immense "commercial agencies." A step in the direction of sound business organization has been taken by the employment of commercial travelers to ascertain a demand before it is supplied. A manufacturer of hats or straw-goods designs a variety of styles for an approaching season's trade, and turns out the quantities ordered and no more. By similar methods many importers avoid carrying large stocks of goods, and are becoming more and more commission-merchants, or brokers, unburdened by the rent of extensive premises and the losses incidental to buying for chance sale.

In Great Britain, every year, more than a hundred million dollars' worth of goods are distributed at retail at a gross cost little exceeding five per cent. In New England the experimental imitations of British co-operation have transacted business at an expense one half more, 7·7 per cent. Retail distribution in America probably costs twenty per cent of the prices consumers pay, and, because of their utter absence of organization, the outlays for solicitation constantly grow. Conspicuous premises are leased at enormous rents to attract chance buyers. Windows are decked by artists whose skill is a specialty, invoking the aid of scene-painter and stage-mechanic. Newspapers are filled with adroit and reiterated allurements. Circulars repeat them; hoardings re-echo them. At home the bell-ringing army of hawkers and canvassers consume time which is money, and patience, which is more. Minor articles of use or beauty are gratuitously distributed, to remind us at every turn of the merits of some pill, soap, or insurance company. Who shall measure the cost of all this to the solicited, in distraction and annoyance? One of the most promising fields

for American business enterprise I believe to be the organization of retail distribution, which, among other economies, can rid itself of the expense of solicitation. We have already great bazaars which combine the variety of a country store by assembling under one roof the special departments of ordinary city warehouses: is it not possible to organize for such marts stated circles of customers, on whose steady trade the proprietors can rely—circles sufficiently large for adequate support, independently of showy premises or other advertisement? Some such organization could offer customers lowered prices in consideration for their agreement to forego the luxury of buying at random. Some such improvement in retailing would make it possible to introduce certain advantages of British co-operation among a public who prefer individual enterprise to board-management. A buyer in Rochdale or London hears from a co-operative salesman the exact truth regarding the quality of his flannel, coffee, or gloves. The salesman has no interest in deceit, and money is expended to the best possible advantage. The profit which attends this replacing an antagonism of interests by an identification has been remarkably exemplified in New England by the factories mutual-insurance companies. These concerns insure more than four hundred million dollars' worth of mill-property, at one fourth the cost of non-co-operative underwriting.

Briefly to summarize them, the chief evils attendant upon competition are those which grow out of ignorance concerning what competitors are doing in a given field; the excessive cost of solicitation in its various forms and consequences; the absence of responsibility when business is in the hands of small firms; and lastly, the immense tax commonly included in the prices of retail sale. It was in the business of transportation that the losses attending unrestricted competition were first severely felt, and first sought to be remedied. Shippers, by adroitly playing one line off against another, were able to lower rates much beyond fair limits, especially when ill-considered rivalry or the profits of promotion and construction had created unnecessary roads. To prevent the recurrence of costly and sometimes ruinous tariff wars, agreements as to rates were made—only to be broken whenever it suited the interests of any one of the parties to do so. This experience at last led to the device of the pool, an ingenious attempt to retain the beneficial features of competition while discarding its evils. A pool, let us say, comprises four trunk-lines connecting Chicago and New York; their business for a certain period prior to the formation of the pool is ascertained to have been in the proportions of thirteen, eighteen, twenty-eight, and forty-one per cent. Freight is then apportioned in these ratios; but if the expressed desires of shippers would vary this allotment, it is maintained,

nevertheless, by officers of the pool known as "eveners." When a second term of the organization is discussed, these shippers' preferences, as growing out of the improved management or facilities of a particular line, are given weight in a revision of ratios. Were pooling agreements legalized so that their terms could be enforced, Mr. Fink, the first railroad authority in America, declares that the principal step toward settling the railroad problem would be taken. In the great work which the Interstate Railroad Commission has accomplished, not the least benefit has arisen from the publicity it has given to complaint. It is now clearly proved that corporations dread condemnation at the bar of public opinion, and that they often have an unsuspected sense of responsibility which can be directed to curtail their abuse of power.

With a home market safe from foreign competition, with the steady swallowing of little fish by great, and the growth of these from great to greater, it was only natural that the policy which aimed to suppress what was deemed undue rivalry in transportation should be paralleled in manufacturing industry. Hence a few years ago we saw associations begun to be formed among producers of iron, steel, paper, salt, and other articles of prime necessity, all intended to regulate output and price-lists. As a rule, these associations did not work well. They lacked the means to punish breaches of faith to which superior facilities or management might tempt one of the associates. Some more substantial bond was called for if agreements were to be respected and harmony of interests maintained. Then arose the "trust," with its organic tie; an industrial creation nothing short of revolutionary. In the most approved form of "trust," such of the concerns to be affiliated as are not incorporated, are transformed into joint-stock companies. Then all the companies, new and old, transfer their property to the "trust," an unincorporated board which represents each of the unified concerns. The trustees then exchange "trust" certificates for the various companies' shares, usually on the basis of a trebled or quadrupled valuation. Control is then exercised by the board over all the operations of the industry thus organized; one refinery or mill is enlarged, another is closed; territory is apportioned to each active member of the combination, output is regulated, prices fixed. Let us mark the prize which tempts to this apparently perilous relinquishment of direct control of its affairs by each party to the union. We can see it best displayed in the case of the Standard Oil Trust.

No chapter in the history of American industry is more interesting than the record of the rise and progress of this "trust." Beginning in 1870 with an inconsiderable refinery in Cleveland, its founders took diligent heed of the fact of railroad competition: "special" rates were then commonly granted to any shipper who

understood the profit which lay in "higgling." These Ohio refiners handled an article whereof freight was a large element of price; so, making "special rates" their opportunity or cover, they gradually succeeded in obtaining enormous rebates from ordinary terms, not only on the oil shipped by them, but on oil shipped by competitors. With this infamous advantage, the growth of their operations and of their power was rapid. Not many years elapsed before they were able to lay a pipeage system for their oil at a cost of thirty million dollars, supplanting the railroad system which had given them their chief impetus. In its struggle to extend and maintain its practical monopoly, the investigations of this "trust" at Albany and Washington disclose how the combats of swamp and jungle may be repeated in counting-house and exchange. Violence and fraud were employed to further the process of pushing rivals to the wall. Clerks were tempted to betray a competitor's confidence, workmen were bribed to explode his stills. To-day the Standard Oil Trust refines three fourths of the petroleum of the United States; fortunately, its interests chime with those of consumers, who therefore share in the benefits of its high and compact organization. The field of oil production constantly widens, bringing to market an increasing volume of crude oil; as the "trust" owns nearly all the transporting, storage, and manufacturing facilities in the country, it finds it best to make prices so reasonable that its sales may be the largest possible. This "trust" possesses almost every advantage which would inure to a state monopoly, managed by eminent ability at work for individual gain. It enjoys the immense saving which results from organizing the whole Union as a single market, whose wants can be systematically ascertained, and as systematically supplied from the trade-center of each territorial division. It reaps the gain which flows from so adjusting supply to demand that labor can be given uniform or nearly uniform employment, which comes from preserving credit from undue cheapening, and thus minimizing one of the chief perplexities of business—the estimation of risks. By unification of management, any new improvement in machinery or process is introduced at once into every refinery the trust controls. Mr. Dodd, one of the Standard's solicitors, declares its profits during 1886 to have been thirteen per cent, a much smaller return than that popularly supposed. It is worthy of note that the Standard people are now buying large tracts of oil lands, presumably with intent to control the production of oil as well as its distribution, refinement, and sale.

Incited by the success of the Standard, a great many "trusts" have been formed, imitating its methods in endeavoring to control the production of some leading article of trade. None of them, however, exhibit the ability of its management, or the sensitive-

ness to criticism and sense of public responsibility which have marked the Standard's later history. These "trusts" fall in the main into four classes—those which, like the iron and steel trust, are fostered by a tariff which excludes foreign competition; those like the envelope trust, which derive an additional element of monopoly from patented machinery and processes; those like the gas trusts, which are of *quasi*-public character, and operate under municipal franchise; and lastly, those which, like the Standard Oil and Cotton-seed Oil Trusts, depend solely upon aggregated capital and unified organization for their supremacy. That lowering the tariff would abate the excessive gains of "trusts" of the first-mentioned kind is proved by the sudden rise in the value of their certificates on the defeat of a national Administration pledged to tariff reform. In so far as abuse of patent-rights is made auxiliary to "trust" extortion, the curtailment or forfeiture of such rights, when so abused, becomes a subject demanding legal redress. With respect to "trusts" exercising *quasi*-public privileges, such as those of gas-supply, the remedy consists in municipal control, as convincingly maintained by Prof. E. J. James, of Philadelphia, in his treatise on the subject.

In considering the difficult questions which the advent of the "trusts" has created, it is necessary to discriminate between those which treat the public fairly and those which exact the utmost the public can be made to pay. If the Standard Oil Trust, disgraceful though its history may be, can prove that it gathers, transports, refines and sells petroleum cheaper than could the competitors whose place it has taken, what can be said against it? Its managers have built up a Union-comprehending organization, and are entitled to share in the results which flow from the economies they have perfected. Fairly managed, a trust is the last term in a process which began when a machine dispossessed hand-labor; which advanced when steam was applied to the machine; which took another step when steam-machinery, operated by massed joint-stock capital, undersold private firms. Industrial progress has steadily marched forward along the lines dictated by the economy of bigness over smallness, of high specialization, of the adjustment of supply to an ascertained demand, the constant substitution of knowledge of markets for ignorance regarding them, the unremitting elimination of chance. To many thousands of worthy men engaged in the rivalry with new methods they have meant defeat and ruin. This is pathetic but inevitable, for, when once men find out some better or cheaper way of doing a thing, they never go back to some costlier or more troublesome plan, no matter who suffers. Excluding then from all combinations to be pursued and condemned those which are controlled with fairness, we have to consider the best course to

adopt with the conspiracies whose aim is nothing but the artificial raising of prices and impoverishment of the public. To cite two examples: Under "trust" control refined sugar is one half to three quarters of a cent per pound dearer in comparison with raw sugar than before the "trust" was formed. Raw linseed-oil, on the establishment of a "trust," was immediately advanced from thirty-eight to fifty-six cents a gallon. Against such extortion the remedy is first and chiefly competition. With capital for profitable investment abundant and cheap, no "trust" is secure in its control of the market. So rapidly and suddenly have the great majority of "trusts" arisen, that competition with them has not yet had time fully to manifest itself. To build and equip a sugar-refinery demands a million dollars and takes a year's time. In an industry such as that of sugar-refining, in which trust-control has been assumed only recently, such independent competitors as remain unincluded derive no little advantage from the "trust's" existence. They are free from regulation of their output, and find a ready market for all they manufacture by keeping their prices a mere fraction below the "trust's"—a condition of things certainly attractive to competition.

To curb and punish the plunderers who, turning their talons from their rivals, direct them upon the public, a variety of legal remedies have been sought. The most important recent decision affecting predatory "trusts" was that delivered by Judge Barrett in the Supreme Court of New York, January 10, 1889, in the suit of the people of the State against the North River Sugar-Refining Company, to dissolve the company and declare its charter forfeited for entering the Sugar Trust.

Judge Barrett's decision declared the charter forfeited and the company dissolved. The grounds of his judgment were that a corporation is liable to be dissolved by the abuse of its powers, or if it has exercised privileges or franchises not conferred upon it by law. He held that the directors of the corporations composing the "trust" had acted illegally in abdicating their direction in favor of the trust-board, to whom all shares of capital stock had been transferred. While corporations have no legal power to consolidate, the "trust" was practically a consolidation, which legally had no existence nor responsibility. He declared, further, that resting upon the inherent right of sovereignty, franchises are granted by the State on condition that corporate privileges shall not be abused, shall not antagonize the safety and welfare of the community. It was held proved that the Sugar Trust had not been formed for protection against ruinous competition, but for the illegal purpose of artificially enhancing the cost of a necessary article of commerce; that the "trust," by virtue of its combined capital and control, had power to crush any rival who, without

equal resources, might enter the lists against it; and that, even if adequate competition with it were to arise, the delay incident thereto would be sufficient for intolerable oppression of the people. The case is to be carried to the Court of Appeals, and its fate there will be of national interest. In the courts of Ohio, Illinois, Louisiana, and other States, it has been decided that all combinations to suppress competition, raise prices, or restrain trade, are illegal, and it has been proposed to attack the "trusts" along the line indicated by these decisions.

Should the illegality of "trusts" in general, as now constituted, be maintained in courts of final appeal, the question emerges, How can the benefits of business organization, which the "trust" includes and has introduced, be secured with at the same time avoidance of abuse by a control practically amounting to monopoly? It is highly probable that, if corporations are denied the exercise of the economic and beneficial features of "trusts," firms attracted by the resulting advantages will establish organizations substantially similar. Indeed, individual accumulations of wealth have long since passed the point where they confer power to control single important industries of the United States. Clearly, then, a question of no little difficulty is before the American people. Ordinary competitive business has in many departments become so complex, unwieldy, and wasteful, as imperatively to demand some such simplification as "trust" organization offers. If that organization be denied to groups of capitalists, the powers sought by such organization will in all likelihood, with some delay, be exercised by individuals who will have all the temptation to abuse their strength into which corporations have been led in the past. Law must in the nature of things lag behind exigency, and in this new transition of business, from competition to combination, it evidently has to confront a problem of supreme importance. In the development of the Copper Trust we have seen how an international combination may become a conspiracy to rob the world: a singular piece of testimony to the obliteration of national boundaries by modern methods of locomotion and communication!

For "trusts" limiting their operations to the United States a line of treatment has been suggested which has doubtless had its origin in legal consideration of the railroad question. Since its settlement is stoutly maintained by expert authority to consist in frank acceptance of the "pool" and its legalization, why not, it is asked, also legalize the "trust," surrounding its control with all the safeguards necessary and feasible? The State already exercises a degree of supervision over certain *quasi*-public businesses—banking, insurance, and railroading. Its supervision may be justly extended to the "trusts," while at the same time the

levy of a just tax will make the people sharers in the advantages of "trust" organizations. Their affairs published, their managers will have a better chance to cultivate a sense of public responsibility than at present, when, without status, their security threatened by attacks of all sorts, they seem intent on making the most of an opportunity which they expect to be brief. Because less in direct legislation than in residual competition lies the curb of extortion, this must be insured by strict enforcement of adequate laws against conspiracy. Were "trusts" legalized, it is said—did publicity attend their transactions—it would be both wise and profitable for them to make the public willing parties to their existence by employing their systematization of business to serve the public better than unorganized competition in the past has ever been able to do.

To this proffered solution of the "trust" question is opposed the objection that it involves an extension of governmental powers much in advance of existing evidences of governmental efficiency. Yet public control or restraint in some form is imperative. Whatever truth the self-regulating theory of private enterprise may have had in the days before combination, vanishes at a time when individual monopoly can levy a national tax in the shape of extortionate profit. However reluctantly we may admit it, more and more does exigency tend to enlarge the scope of State authority. Hence greater need than ever that public-spirited effort should purify politics, and endeavor to lift it to statesmanship. When the nation has been threatened by foes without or within, her citizens have ever given prompt response to the call for defence. To-day she seeks protection, not from armed invaders, but from economic oppressors. It is war again, but war demanding in its generalship not only courage in an unpicturesque field, but business sagacity of the highest order.

KNOWLEDGE of geography is important, says General R. Strachey, to the statesman, because upon it depend largely the right determination and definition of boundaries, the lack of which has been the cause of some of the greatest differences between states; to the soldier, for the intelligent planning of his campaigns, marches, and minor movements; to the engineer, who must have exact representations of the horizontal and vertical features with which he will have to deal, and knowledge of the climate, rainfall, and natural productions of the country; to the physician, who prescribes "change" to his patients; to the merchant, for the judicious dispatch of his wares; and to the emigrant, for a wise selection of his new home. Geography furnishes the key to the interpretation of many events of the past, and materials and aids in scientific research. Meteorology is largely indebted to it for the advance it has recently made. Without the aid which exploration has furnished, the generalizations of Darwin and Wallace concerning the origin and distribution of species and the influence of geographical conditions could not have been obtained.

LAW AS A DISTURBER OF SOCIAL ORDER.

By BENJAMIN REECE.

NOTHING is more perplexing to the inquiring mind than a contemplation of the great contrasts between the harmony and adaptation existing in the material world and the incongruities, antagonisms, and disorder which characterize the social and moral worlds. When one realizes how successfully the inventor and the artisan have followed the teachings of the scientist, he can not but suspect that much of our social unrest has arisen because our law-makers and philanthropists have not followed the teachings of social philosophy.

The fact is patent that, in the material world, where man's hand is powerless to interfere, there are perfect order and harmonious development; but in the moral and social worlds, which are always subject to man's petty and ill-considered meddling, we have great disorder and confusion. So marked are the incongruities of social condition that the philosophic thought which has failed to grasp the vital elements of development seems to be divided by the extravagant superlatives of pessimistic and optimistic expression. In his criticism of Mr. Herbert Spencer's essay, "Man *vs.* the State," Émile de Laveleye recognizes this uncertainty and want of harmony in human affairs, but fails to see that the disparities are caused by man's interference with the laws of his own being and development. He says: "Nature is subject to certain laws which are invariable, as, for instance, the law of gravitation. We may call these laws of nature, but in human institutions, which are ever varying, nothing of the sort can exist." He fails to realize that the law of gravitation is invariable because man's hand is powerless to change it, but directs its cunning to the construction of screws, levers, and inclined planes, in order to obtain mastery over nature.

Suppose the power had rested with man to substitute human contrivances for this unvarying law of nature, what inextricable confusion had resulted! Suppose the citizens of the vast territory whose commerce is tributary to the Northern chain of lakes should call upon their senators and representatives to devise ways and means by which to conduct their foreign trade direct from the lake ports, without first transshipping to, and thereby paying tribute to, the cities of the Atlantic coast. A physical difficulty at once presents itself, insomuch that the shallow-draught vessels of the lakes are unfit for ocean service, whereas the deep-draught vessels of the Atlantic are unable to enter the shallow waters of the canals and harbors of the lakes. After various consultations

and debates, it is determined to correct this inequality of material nature by passing a law doubling the specific gravity of water in the lakes, so that ocean vessels drawing twenty-four feet of water can sail upon the lakes with little more than twelve. Is it not apparent that this single law would destroy the adjustment and adaptation of ages? Fish having been developed in water of normal density could no longer live in the lakes; the weeds and grasses which had grown upon the bed of the lakes would be uprooted by the water of double weight, to float upon the surface, and, being subjected to the sun's rays, would decompose and scatter the germs of pestilence and disease. The weight of water being doubled, it is made a little heavier than sand, so that the farms of sandy soils in Michigan and adjoining States would float away upon the waters of the lakes. Trees would be uprooted, the heavier clay soils, bridges, wharves, and railroad embankments washed away.

Then would follow an active period of legislation to neutralize the evil consequences resulting from the original interference with normal adjustments and relations. While seeking to retain all the advantages gained to commerce by the increased weight of water, law after law to restore the equilibrium would be enacted, and, where harmony and universal order once held sway, confusion worse confounded would obtain. That soils and lands might not be washed away, laws would be passed doubling their specific gravity, which would bring them nearly to the density of stone, rendering tillage very difficult and costly, while the seeds could no longer pierce through to the surface. In order that railway embankments might stand and resist these waters of such tremendous weight, the specific gravity of materials used in their construction is also doubled, but doubling the weight doubles the cost of handling and constructing, and the estimates of contractors and engineers prove worthless. Is it not evident that the waters of the lakes being doubled in weight leaves all other forms of matter correspondingly light, and the selfish propensities of men are at once aroused. Those interested in shipping desire water of increased specific gravity; those subject to floods demand legislation looking to a decrease in the weight of water; while the much-abused *doctrinaire* declares that the normal adjustments of ages upon ages could not be disturbed without disastrous consequences, for one law changing the relation of water to other forms of matter, makes necessary the passage of thousands of intricate laws in order to restore the equilibrium so ruthlessly destroyed, because of the vain attempt to enlarge the scope and power of one element without the corresponding diminution and weakening of all others.

In the contemplation of the material world, no discovery of

science has worked more marvelous changes than the generalization known as the persistency or indestructibility of force; yet in the moral and social worlds its teachings are almost entirely disregarded. In exerting force in any form, it must be applied to something, and, whenever or however applied, that something will react with a force equal to and in an opposite direction to that which is applied. The man who lifts a hundred pounds' weight, finds the weight pulls one hundred pounds upon his arm; the man who strikes a blow, receives upon his fist a shock of equal force to that which he imposes upon the body of his antagonist: should he miss his aim, the direct force would react in a pull upon the shoulder, and might result in the dislocation of the joint. One pushes against an object until red in the face, but the redness of face and exhaustion are not caused by the direct application of power; it is because the object reacts in resisting or pushing with a force just equal to that which is applied; and, but for this pulling and pushing in reaction, men could apply force without expending force, could accomplish work without exerting energy, both of which are contradictions of terms and absurdities.

Notwithstanding this invariable law of nature, legislative enactments are daily made providing for the exertion of social and moral forces, without one thought of the reaction which must inevitably follow; and I may here say that Nihilism and political disorders in Russia are the reaction due to laws which restrict political rights; the agrarian troubles in Ireland are the reaction due to its onerous land laws; while our industrial unrest is but the reaction due to legislative interference with natural industrial forces.

The mechanic in moving large bodies secures the aid of lever, screw, or inclined plane, and is obliged to apply as much energy as the body offers resistance. In mechanics the principle of the correlation and conservation of forces is always acknowledged and obeyed; hence the unerring certainty of performance and the stability of the vast and intricate structures of the age. When large bodies are to be moved, physical energy is applied in the form of great power at low speed; where parts are to be severed, or fracture is sought, or where molecular instead of molar energy is desired, it is obtained by impact at high velocity, as is instanced in the firing of projectiles against a vessel's armor-plating: the energy applied is exhausted in penetrating the armor and generating heat, instead of imparting motion to the vessel.

In the social no less than in the material world, force is indestructible, and in the latter the hostile meeting of two unyielding bodies in collision arrests the molar energy to reappear as molecular with its equivalent in heat. So, if two social bodies meet and

arrest each other's action entirely or in part, reaction follows in the form of irritation, passion, and vengeance, to which the French Revolution and other popular outbursts bear ample testimony; and these excitations of the inner man are exactly equal to the social forces in antagonistic equilibrium, and it is this form of energy which now gives rise to the warring tendencies and bitterness of classes.

But look at our legislation. Its presumed object is to move the whole social body upon higher planes of progress; yet it essays to urge forward this vast and intricate structure by the impact of quickening laws, by the concentration of social forces into certain lines; and to these ill-considered attempts can we attribute the present incoherent social state. The social organism fails to advance as a whole because power is converted into speed, and thus applied it has torn the social body into several parts. Capitalists and laborers, millionaires and paupers, moralists and criminals, are being urged upon separate lines with varying momentum, the acceleration of speed at the expense of power finally resulting in urging one tenth part of the population ten paces in advance of the masses, when, but for this transmutation of power into speed, the whole body of the people would have advanced one step together. If the few continue this heedless progress at the expense of the many, the separation will be more and more pronounced; and the wider the gap thus made, the more severe and disastrous will be the concussion in the day of readjustment.

Through the laws of force we learn that, when individuals or social groups pull together, the resultant is equal to the sum of their separate effects; but if they pull in opposition to each other, the resultant is found in the difference of their separate effects, and, should they be equal in power, equilibrium would ensue and no work could be accomplished.

Yet in spite of this unvarying law of nature, relentless war is being waged between the classes, causing social unrest and industrial turmoil; and, having been taught that in the ballot resides the remedy for all real and fancied evils, each class clamors for legislation, not to conserve the ends of justice, but to increase their own power or decrease that of the opposition, and thereby secure the object of their strife. Politicians discerning this incoherency of the body politic, are quick to take advantage of it by appealing to every selfish interest, hoping thereby to gain the honor and emoluments of place. In the mass of State and national laws daily enacted it would appear as if the American citizen, or society at large, is utterly disregarded. Of laws we have a surfeit, but they are aimed at voting groups and fail to comprehend the good of all: pension bills for soldiers, river and harbor bills for river and coast constituencies, protective tariff laws for

manufacturers, labor legislation for workingmen, land grants for railroads, interstate commerce bills for shippers, subsidies for ship-builders, and oleomargarine bills for farmers—and yet the conflict rages, cries are raised against the arrogance and grinding avarice of monopolies, while bitter complaints are made of the domineering independence and unsteadiness of labor. Is it not evident that, if these selfish elements continue to repel forces which should be mutually attracted, the continued and increasing strain must result in violent and acrimonious rupture?

Most writers upon social science fail to grasp the fundamental principles underlying social growth. They seize upon half truths only, and according to their impressions they attach more or less importance to the egoistic or individual forces of character or to the tribal or social forces, as the case may be. Thus Mr. Leslie, in his introduction to De Lavelaye's "Primitive Property," claims to see nothing but strife and contention in the universal desire for individual property, and he urges with much spirit that it is not strange that all should desire to possess; but, says he, "what needs to be explained is that such warring elements, each desiring the same objects, should permit peaceful possession by others." Mr. Leslie fails to realize that such contentious forces must find some common base of action to escape from internecine strife; this is true not only of man, but of all gregarious animals. Even Mr. Clifford, in his "Scientific Basis of Morality," is disposed to view the social or tribal characteristics of man as the more essential to survival; but carried to its extreme, this submission to the wills of others results in the inaction of physical torpor, even as the extreme development of the individual traits of aggression result in the inaction of equal forces in conflict. Hence the two forces are correlated, and if they are separated by friction this civilization will perish, as its predecessors have done.

An analysis clearly shows that in the absence of extraneous interferences the reactive effect of individual aggression is resistance and social union, for which we find many forms of expression. Individual force is made manifest in the declaration of "I will do," "I will not do," while the reactive or social form finds expression in "I will or will not permit to be done." In the individual traits are found those activities which reside in purpose or in free will; in the social group we mark the modifications of environment sometimes called destiny or foreordination. Thus each individual is at the same time acting upon others and being acted upon by others, and, as action and reaction are equal and opposite, the aggressive force of all individuals is just equal to the resisting force of society in the aggregate. When these two forces develop in the same individual, we find law-abiding, just, and energetic characters; but when separated by friction, there

are injustice, bitterness, and rancor. Upon this law does the development of society depend, and in the aggressive forces are found the elements of progress, while in the submitting and resisting forces are found the elements of stability. To the aggressive features of Western civilizations is due that rapid progress which has heretofore proved wanting in stability, while to the well-defined social conditions of Eastern caste is due the stability of the civilizations of the Orient, which have for ages lacked the elements of progress. Science formulates the theory, but not until taught by bitter experience does man seem to understand that by union and interaction we secure a resultant equal to the sum of our several activities, while by conflict and counteraction forces are neutralized, or at best the resultant can be no greater than the difference between the several effects.

The lowest races respect the rights of property among themselves. Mr. Darwin says of the Fuegians: "If any present was designed for one canoe, and it fell near another, it was invariably given to the right owner." It goes without saying that from the docks of one of our populous cities, in the midst of civilization, no such respect for the rights of others would be observed. But, in the state of ungovernable passion which characterizes the savage, is it not evident that a disregard of the personal rights of others would soon end in practical extermination, while by respecting the rights of others each gains security for his own?

It is idle to speculate as to the occasion of this nascent trust or confidence on which all societies rest alike in their infancy of ungovernable violence and in the maturer developments of the restraints and social order of our present civilization. It is true the stinted trusts of the undeveloped limit the duties they create, while the extended trusts of the more evolved imply the creation of new duties coextensive with those trusts.

Let us, for illustration, suppose that two savages, in pursuit of the same game, cross paths; immediately they turn upon each other; being evenly matched, neither gains the advantage, but the game escapes, their activities being lost in the attempt to thwart each other. With frequent repetitions they ultimately realize that to work with is more profitable than to work against each other, and the first step toward civilization has been taken.

It is reasonable to suppose that the first associations of men were intermittent and capricious, the bond of union being often severed at the will of either as personal advantage seemed to dictate, and that the discernment of the permanent blessings of social union was of slow and uncertain growth, and not until a long period had elapsed would the trust of either be so complete as to make treachery possible; for this augmenting trust is of mutual growth or dissolution, the former removing fears and stimulating

reciprocal confidence, the latter leading to renewed watchfulness or inducing retaliatory aggressions.

Primitive man, being unrestricted except by the wills of others, would find himself in an environment in which his will would be moderated by the desires of others; and, whether the first bond of union had its origin in accident or experimental degrees of association, it is evident that, so soon as the advantages of the new conditions were experienced, the new duties involved in the new trust were readily acknowledged and willingly performed: and this coming together from a state of isolation, until by slow and gradual growth a visible bond of union was established, must have been a dual development, in which trusts and duties balanced, for mutual benefits give rise to mutual obligations, and not until a breach of duty revealed the existence of new dangers would an enforced compliance, much less a compact, be suggested.

"Do as you would be done by" is the natural inclination of man, and, though weakened and impaired by legislation, its many features still endure, for upon the operation of the golden rule does the permanency of all bonds of union rest. The dishonest gambler is watchful of the play, expecting to be cheated; he does not hesitate to cheat in turn, but he holds with sacred regard the debts of honor contracted at the table. The Texan cow-boy who shoots his man at sight would scorn to hide himself from the fury of an antagonist; careless in taking the lives of others, he is equally reckless concerning his own. The Indian neither extends to others nor hopes himself for mercy. The untrusting are unworthy of our confidence; thus love begets love, confidence inspires confidence, and with our higher types of manhood those superior to the law will transgress its mandates rather than violate their conscience, of which class we have records of many notable examples.

The whole history of human development is replete with the recognition of new duties, and the primitive bonds of savage union have been successively extended from families to tribes and clans, thence to states, which have further united into nations, while the final evolution points to a universal brotherhood. As previously stated, these two forces are met with everywhere—the active and the reactive, the positive and the negative, the aggressive and the permissive, the individual and the social—but they have been separated by legislation, much as you would separate the electricities by friction, and, as with the electricities, the like forces are repellent, while the unlike are mutually attracted.

Let us apply this law of nature to a well-known and familiar evil. I refer to joint-stock companies and corporations. The corporation of to-day differs from those of the Elizabethan period, in so far as such grants were then regarded as special favors, often

conferred because of services to the crown, either promised or performed; while the joint-stock company of the present age is adopted as an institution, without any pretense of making returns to the state for favors received.

Every new era of material progress must be accompanied by its moral correlative, which is implied in trust, else treachery is sure to follow; and only as men enlarge their confidence can honest co-operation be extended. In the beginning of the present century, the age was ripe for co-operation in its industrial forms; and it would be the distinguishing feature of our present development, had not impatient legislation introduced the joint-stock company as a legal substitute. At the period of history to which we refer, the nobility still retained possession of the land, and deemed it vulgar to engage in trade; while the merchants had amassed large fortunes in the commerce which had sprung up from the daring explorations, enlightened navigation, and energetic colonization which followed the discovery of the mariner's compass. Small shops abounded; the master-workman, journeyman, and apprentice were friends and comrades, the apprentice becoming journeyman and then master-workman in turn. In the revolutionary struggles which marked the commercial age, a fair measure of free speech had been attained; and the scientist, being free to give to the world his discoveries, was quickly followed by the inventor, who applied these discoveries to the wants of man.

Is it not pertinent to inquire why, under such conditions, science, invention, and co-operation did not flourish and develop together; and why the scientist, the inventor, and the artisan, do not share the profits of their joint creations and endeavors, which profits are now largely absorbed by capital? How is it that, with enlarged mechanical possibilities, the small shop-owners have been driven from the field of proprietorship; and the master-workman and journeyman of a hundred years ago are to be found at the bench or lathe of the mammoth workshops of the day, not as independent workmen, but as mere automatons, to pull the levers which release the cranks, gears, and pulleys of the machinery which performs the former labor of their hands?

It is often urged, and with apparent seriousness, that in this republic every man has a chance to become the owner of one of these vast establishments! What monstrous folly to claim that every man can become the employer of a thousand men, when, by implication, for every proprietor there must remain a thousand men to be employed; so, with all the vain-glorious self-congratulation, it simply means that out of every struggling thousand one may reach the goal! Driven from so untenable a position, it is declared that the fittest will survive, which, being a half-truth, means nothing, for fitness has no existence apart from its environ-

ment. A cow-boy's fitness consists of quickness of sight and dexterity of hand. The savage depends upon skill in hunting and success in war. Fitness may reside in the longest purse, the lowest cunning, or the basest treachery, according to environment. The very fact that the possessor of wealth absorbs the profits of discovery, of invention, and of handicraft is sufficient reason to demand an inquiry as to what legislation has given us so distorted an environment.

The forces required for the industrial age are, first, capital, and, second, as in every other progressive step, an extension of trust or confidence; or, to use another form of expression, first, the individual forces, in which are found aggressive action or energy, thrift and prudence, all of which are implied in capital, but in such characters are often found wanting the true sense of justice—hence strong individuality may exist and still be distrusted and itself distrusting; second, the social forces, which are permissive, fair, honest, and just, all of which are essential to confidence—but these may all exist without energy, thrift, and prudence, which are implied in the possession of capital. Co-operation, then, is dependent upon a union of the social virtues which reside in confidence, and those personal morals which are typified in capital. Had these qualities been developed in the same individual, no laws would have been necessary to encourage combinations of capital to enter wider fields of production. The incentive to action is the expected reward, and in this case the inducement could be found in the large profits which combinations made possible.

If, then, at the beginning of the present century, the rich returns promised to those who would co-operate were fairly discerned, and in spite of such discernment men failed to enter into co-operative action, it is evident that moral and not material growth was essential to the true progress of the race, and any law looking to the stimulation of material agencies could not but impair and weaken the moral forces of development.

The fact that men of wealth would not combine for the carrying on of great projects which promised enormous profits, is evidence that they lacked confidence in each other, and to their minds treachery would surely follow trust. Upon the other hand, we find the artisans and mechanics then, as now, bound by the closest ties of fraternal friendship, born of mutual dependence and mutual trust; but they were wanting in those individual elements of character typified in the possession of capital: hence, so far as industrial pursuits were concerned, their trust and social qualities were without avail for want of money to make their combined efforts effective. We thus find that the rich men of that time, although able, were unwilling to combine, while the mechanics were perfectly willing, but unable for want of means. It must be plain to

all thinking men that further moral development was absolutely essential, and, in the absence of legislation, an energetic moral growth would have followed a recognition of the permanent benefits to be derived by this further extension of trust. The rich, by fair dealing and strict integrity, would aim to prove their worth and show to their fellows that with added trust they would perform the corresponding duties. The artisans and mechanics would have been stimulated to energy and moved to thrift, prudence, and abstemiousness, in order to secure the capital with which to render their mutual trust available for industrial co-operation; and while ten men with ten thousand dollars became convinced of each other's worth, a thousand workmen would have saved one hundred dollars each, and in this manner in action and reaction each class would have developed the weak sides of its character, and, the growing integrity of the one meeting the increased energy and prudence of the other, would have gradually lessened the disparities of condition which then existed, instead of which we now find them constantly widening, and co-operation would have been the normal growth.

It is frequently claimed by the unthinking that co-operative unions are unable to select proper leaders for direction, whereas all history belies the claim. Whether in the playground, in the feudal ages, in times of great public peril, or in popular revolutions, the leader is recognized spontaneously, and the masses have seldom failed to make a wise selection. It is true that the co-operative concerns which have their origin in the hot-beds of experimental legislation have generally failed. But who shall say that failure would have resulted with the hardy plant which has been shown to be indigenous to the soil of the present age?

The natural evolution of material progress seemed too slow, and legislation was called into play to hasten the day of industrial activity. Since each class possessed one of the essential elements of industrial progress, it is evident that two ways were open to accelerate its growth. It could have been accomplished by providing the artisans of the age with government aid in money, in which way the state would have provided men a substitute for thrift, energy, and prudence; but government has no more right to do this than she had to furnish the rich a substitute for honesty and justice, and, as limiting the liability of the one has united dishonest elements and given additional power to the strong, so would and so has government aid in money led to a union of the shiftless and improvident and made still weaker those who for want of aggressive individuality have thus far failed to assert themselves; for, being provided with the results of energy and prudence, those qualities would no longer be developed in an environment which furnished them without effort or activity. We

may here say that this method has seldom found favor with legislators.

As is usually the case, if legislation is to be invoked, it is generally in favor of those already strong in aggressive energy, and with these legislative aids the way is paved for the rich to become richer and the strong to become stronger. In this case the rich were furnished a substitute for confidence by a law which limited the duties and the liabilities of those combining, whereas it has been shown that in a healthy social state trusts and duties must be coextensive.

Legislators practically declared that, while they could not make men honest, they could establish confidence by so limiting the liability of those combining that honesty, instead of being an essential element of trust, would be inconsequential as an industrial force, for the possible chances of loss to the investor should be small. In this manner legislation pushed men together who would not be drawn together by mutual confidence; and society, having seen fit to trust those who would not trust each other, now complains of the insolence, injustice, and dishonesty of corporations! But, while denouncing corporations in unstinted terms, there are those who still regard them as a public blessing, essential to the times, but pray their legislators to deprive them of their sting, much after the manner of those who, while insisting upon the heavier waters of the lakes, would seek to legislate away the natural and inevitable consequences of doubling their specific gravity.

Those possessed of capital are entitled to its rewards. Those enjoying the confidence of others are equally entitled to its blessings. But, in providing the capitalist a substitute for confidence or trust, government neutralizes the forces which reside in honesty and justice, and makes inert as an industrial factor the trust and confidence of the poor.

Is there an enterprise of uncertain origin or doubtful purpose, it appears as an incorporated company. Firms upon the verge of bankruptcy, or about to take hazardous risks, change a partnership into a joint-stock company. Swindling patent-right, insurance, and mining schemes all take the form of corporations; but if the liability of a joint-stock company is limited, it simply means that the possible losses to society are without limit. An incorporated company with one hundred thousand dollars' worth of stock fails for eleven hundred thousand dollars; the company is liable for a hundred thousand dollars in addition to their stock, while the trusting public is called upon to lose a million dollars. Why, in the name of justice, should society give to corporations unlimited chances for profit, when, in case of loss or failure, society itself must bear the burden of all losses which exceed the

limit of liability? If the corporation incurs debts exceeding its liability, legislation can never make those debts less; at best it but relieves the stockholders, and makes the trusting public stand the losses of the untrusting capitalist, and throws upon the shoulders of the innocent the debts of the careless or dishonest.

But the indictment against the corporation does not end with complaints of its arrogance and unjust and dishonest methods; but its impersonal relation to society and labor is a source of growing irritation, and threatens to make the labor question a most perplexing problem. In transferring the liability from the individual to the certificates of stock, personal responsibility was extinguished. The importance or standing of a stockholder no longer depends upon his wisdom, his uprightness, or integrity, but upon the amount of his stock; and, wherever the stock is found, there the authority and liability reside, notwithstanding the stock may be yours to-day and mine to-morrow. Corporations having no personality have neither moral nor social obligations, which are, or should be, imposed on all alike; but not only are they thus relieved of duties, but even the legal liability is a limited one only.

Stockholders, screened behind their stock, will vote measures toward their workmen which they would never dare to enforce as individuals, for then they would subject themselves to the moral condemnation which unjust and ill-considered action merits; but this impersonal relation of capital has introduced into our industrial system a state of affairs resembling that of absentee landlordism in Ireland, in which the manager acts the part of "my lord's agent."

The stockholders of a corporation may be scattered over every portion of the country or even throughout the world, and their interests are in the hands of managers who best show their worth by increased dividends, and, instead of serving as connecting links between capital and labor, they more frequently serve as severing wedges. It is by no means infrequent that men's wages are reduced dimes per day to increase the earnings, while the manager's salary is increased thousands per year as a reward for his fidelity. In this manner cheerful loyalty is giving place to a spiritless, sullen performance of duty. Is it any wonder that a bitterness is being engendered against capital as such?—for, when divested of personality, personal contact and, therefore, personal feeling are impossible. In the course of twenty years' experience, I have seen cheerful compliance grow into indifference, and that indifference gradually turn into feelings of smothered hostility.

This want of personality is also debauching public morals, and juries will render verdicts against corporations in spite of facts and the law. Interests which should be mutual, forces which

should interact, are constantly arrayed one against the other, and the aggressions of the capitalists, who, through the medium of trusts and other devices, ruin their competitors and control prices, are confronted by the strong social forces made manifest in the close unions of labor, which find expression in frequent strikes and boycotts.

What, then, is the remedy? Various cures have been suggested, and, among others, some look to governmental control; but this would deprive us of aggressive individuality, in the same manner as the corporation has deprived us of the justice and honesty derived from natural trust and confidence. How may we retain the vigor and energy of individual push correlated with honesty and justice? Is it not plain that, with the restoration of personal liability, dishonest elements would scatter and their combinations dissolve?

It is asked, "What would then become of our great railway systems?" One thing is certain, although the impersonal corporation might vanish, the railways would remain, and there would be those to run them. If the persons united in the consolidated lines would trust each other (and if they will not, why should the public trust them?), such lines would continue as at present. If distrust should prevail, the Vanderbilts, for instance, might withdraw their capital from the West Shore, Michigan Central, Lake Shore, and other properties, and concentrate upon New York Central, leaving other capitalists to similarly withdraw from many properties, to concentrate and be responsible for one; and thus at one blow would be dissolved the mammoth consolidations which legislation has vainly aimed to check.

If, as would no doubt be threatened, our large manufacturing establishments should close, in a very short time the workmen would take possession, even as the liberated negro slave is now gradually becoming owner of the lands upon which he served in bondage. Trusts would scatter to the winds, for unfair and dishonest elements, no longer trusted by society, would prey upon each other, while the honest would withdraw, to unite among themselves. Material development might be retarded for a time, to make way for the moral growth essential to the proper conduct of industrial development. With this accomplished, cooperation would be an established institution, and the interests of capital and labor, now in constant conflict, would be united, and society would be rewarded by a resultant equal to the sum of their joint effects. Thus we have seen that in the industrial, no less than in the material, world action and reaction are opposite and equal, that force can neither be created nor destroyed, but, when it seems to disappear, it lives on, to reappear in new and equivalent effects.

AMONG THE FIJI ISLANDS.

By COUTTS TROTTER.

IT is a very trite remark that the Pacific Ocean often emphatically belies its title. I can not altogether defend it; and, in fact, it would be unreasonable to expect consistency from so vast an expanse of the unstable. When the grateful Magellan, escaping from the wintry horrors of the region now always associated with his name, burst into the sunshine and balmy breezes beyond, he did not, naturally, reflect very closely on the area over which the new name was to be applied. Big generalizations are dangerous; but it is not absolutely a misnomer, and those who have known this ocean for weeks together in its more gracious moods—whether on its vast solitudes or among its scattered island groups—will readily admit the justness of the title.

On the morning we reached Fiji the sea was without a ripple, and as we passed the pretty island of Mbengga, we scanned its rich green slopes in vain for a sight of life. Primitive man and his works do not show out prominently against tropical nature. A slight haze veiled the great island of Viti Levu—i. e., great Fiji; but, as we came nearer, its grand and varied outline stood out clearly in front of us, stretching far away to right and left. Suva, the seat of government, has no striking features. The houses lie scattered for a mile or two along a neck of land on one side of a bay, at the head of which enters the Tamavua River. A reef with a navigable opening crosses this bay, and forms a fair harbor. But the marvelous fantastic outline of hills beyond the bay—King David might have described them as "hopping"—seen from the broad veranda of the Club House Hotel, was a view of which one never tired. My expectations as regarded hotel accommodation being small, I was agreeably surprised to find a well-ordered, comfortable, two-storied house. It is true that the chambermaid was a little black Solomon Island "boy"; but his views on cleanliness, and on *meum* and *tuum*, were not appreciably behind those of his profession in Europe; and he was, besides, when at home, a man-slayer and a cannibal. The only drawback, indeed, to comfort lay in the fact that the bedrooms were all open to the roof of corrugated zinc, and the noise of the torrents of rain—I never saw rain like it—was deafening. But rainy days, at that season anyhow—well, at all events, it *is* the "dry season."

Boat-voyaging in those regions is not only an enjoyable, but in Fiji almost the only mode of locomotion, though there are horses, and the number of tracks has of late years been consid-

erably extended. Organized facilities for travel do not exist; but the traveler's path will be smoothed if he brings introductions to some leading official, or to one of the principal traders or planters. If he wisely cultivates the society alike of the official and of the non-official class, he will realize more profoundly than he ever did before the great truth that there are two sides to every question. To this unfortunate antagonism I shall return later. Meanwhile I recall, with mingled sensations, a voyage of a fortnight in an open boat along the northern shores of Viti Levu, the principal island of the group, and about eighty by fifty-five miles in extent. The preparations for such a voyage are at all events simple. Of personal luggage the less the better—say a change of raiment and a mosquito-net, or "screen" as they call it in the colonies; for provisions, besides a tin or two of biscuits, some tea, whisky, and tobacco, you require only an assortment of the useful but most innutritious "ironclad"—i. e., tinned meats, here in universal use, and curiously in great demand among the natives, probably owing to the little trouble they involve. Hardly a coral strand in Fiji so romantic or remote but it may be found strewed with the empty tins. Judging from their effect on myself, I should cite them as a most potent cause of the decline of the native population!

We started punctually, *Vaka Viti**—that is to say, having been trysted on board for Saturday at daybreak, we got under way on Monday afternoon. Indeed, only a man of exceptional energy like my conductor could, I was assured, have performed such a feat. Meanwhile the delay had nearly led to our spending a night *al fresco* on the Rewa River, whose famous mosquitoes would have left little of us to tell the tale. These Fijian rivers are of great size relatively to the extent of the land, and the delta of the Rewa forms the eastern extremity of the island. We had intended, accordingly, entering by its southern mouth, some miles distant from Suva, to ascend the stream some way, and thence down another embouchure to the northern coast. As it was, night overtook us soon after entering the river; and, although we at last sighted a light which indicated a house, there was much grounding on mud-banks, and retracing of our course, and weary hours of pulling, before we reached the desired point. My host being on an official tour, and thoroughly acquainted with the people and their language, there was but little difficulty about our reception anywhere—not that any respectable traveler could have much difficulty among these amiable people. Hospitality here, after all, is a simple matter, for native food is plentiful, and there is usually room for everybody, besides that the chief of the village has often more houses than one.

* Fiji fashion, according to Fiji notions.

The ordinary Fijian house looks, outside, like a great oblong hay-stack, standing on a mound raised some few feet above the surrounding level, with a long ridge-pole extending beyond the roof at either gable, its ends sometimes ornamented with shells. The hay-stack has a doorway or two, with a mat suspended in it. Houses with greater pretensions, however, have the walls prettily latticed with reeds, and distinct from the roof, which is elaborately thatched, with great projecting eaves. Inside, immense posts, usually of *vesi*-wood (*Afzelia bijuga*), and a very ingenious framework, support the roof. The interior decorations of sinnet (cocoanut fiber), always in rectilinear patterns—for they do not affect curves—are sometimes pretty. The black, squared lintels of the doors are the stems of tree-ferns. On a great shelf overhead is stored the family *lau*, a convenient Fijian word equivalent to the Italian *roba*. Here it comprises their fishing-gear, huge rolls of *tappa* or native cloth, mats, immense pottery vessels, and the like. The shelves were also handy in war-time as a point of vantage whence you could conveniently spear your neighbor as he entered, and before his eyes became used to the subdued light. The floor is strewed with mats, on which you recline, and is usually raised a foot or so toward one end, which enables you to take a graceful attitude, leaning on your elbow. Cooking is done in a little hut outside, or sometimes there is a great fireplace on the floor, confined by four logs, the smoke finding its way out through the lofty roof. As you enter the house, you find the mats being swept, or fresh ones unrolled and laid down. Your traps are brought up from the boat, and, if this happens to have grounded half a mile from the shore, you have perhaps yourself been carried to land by these willing giants. A few words are exchanged with the village chief or your host for the time being—far too few, to my mind, even for politeness. I am told they do not expect it. If they have ceased to expect politeness from English gentlemen, *tant pis!* I am helpless from ignorance of the language, and you hardly ever meet a Fijian who knows any English—the missionaries, in whose hands their education has been, having, wisely or otherwise, discouraged it. The silent *séance* then till supper came, and indeed after, surrounded by those pleasant and dignified faces, for whom I was necessarily dumb, was often very irksome. Supper, however, comes at last, provided from the materials before mentioned, and supplemented perhaps by an offering of fish or turtle. The latter sounds sybaritic, but it is very far from being a delicacy when badly cooked, and still less so when not quite fresh. And there is of course, as accompaniment, the ever-present and ready-cooked yam, or *kumara* (sweet-potato), or *dalo* (an arum-root), or bread-fruit, or cassava (manioc). I think I have arranged them approximately

according to their insipidity and unsatisfying qualities. I tried hard to appreciate these famous vegetables, whose very names recall endless picturesque and savage associations; but I never succeeded, and hardly know which I disliked the least.

Sometimes we produced a root of *kava*, or, as the Fijians call it, *yanggona*, always a welcome gift, and handed it to our native companions to prepare the national brew. I suppose most people by this time know the orthodox mode of preparing this. It is chewed, or ought to be, as in Samoa, by young and of course pretty girls, and the masticated stuff being thrown into a bowl and mixed with water, the woody particles are fished out with a wisp of the fiber of *vau* (a malvaceous tree, *Paritium* sp.), and the liquor is then carried round to each guest in order. Of course, by the old school this mode of preparation is thought very superior to the Tongan innovation of pounding or grating the root. Certainly, the ingredients differ somewhat, and the dash of human secretion in the orthodox mixture possibly promotes digestion—an effect not to be despised after a square meal of half a dozen pounds of yam! Even in the humblest *ménage* the national bowl is not prepared without some form and circumstance—elaborate traditional motions of the hands in clearing the bowl and rinsing the fiber, strict attention to precedence in handing the cup to the guests (a matter in which, when Europeans were concerned, I was in other islands sometimes consulted), and to other points of etiquette, the transgression of which is viewed with some severity. Thus, it is *de rigueur* to empty your cocoanut cup at a single draught. On my first occasion of drinking I had neglected this rule, for the cup was large, and the taste, as I thought, nasty. Accordingly, on returning the cup, which you do by sending it spinning along the floor to the master of ceremonies, the usual quiet clapping of hands and murmur of applause which should follow this were withheld. On discovering the cause of the silence, I hastened to explain that I had never tasted the cup before, and thought it so good that I could not resist prolonging the pleasure, but I saw that my solecism was too great to be easily excused.

The *kava*-bowl, tobacco, and family prayers exhaust the evening's programme; and my companions being all asleep—why people waste so much time in sleep in this interesting world I never understand—I look out some suitable rafter whence to hang my mosquito-screen, and turn in—not, for the first night at all events, to sleep, for Mother Earth, considered as a mattress, is hard, and deficient in spring; but there is, anyhow, no other impediment to sleep; the cleanliness inside the houses is remarkable—no fleas or other vermin bred of dirt or carelessness. Flies and mosquitoes are supplied by Providence, and the latter have recently been discovered to be "good for us"; but as you listen

to their baffled drone outside the curtain, you feel that you can waive your claim to such advantages.

I attended, at the Vale-ni-Bose or council-house of the province of Ba, a half-yearly meeting of the chiefs, who assemble to discuss the affairs of their respective districts; and, though my interpreter gave me only an outline of what was going on, it was impossible not to be struck by their readiness and intelligence, and not less by their gravity and gentlemanlike manners. Among other incidents, some men were brought up who had tried to leave their district without permission for another; and the utter humiliation of their look and voice, coupled with the dignity and severity in tone and bearing of the chief's reprimand, was very dramatic. To be sure, not very long ago he might have ordered them to the oven!

This same *Roko* or high chief, a shrewd-looking man with a refined and well-shaped head, related with much humor how, on a certain occasion, when a missionary was coming through, and the people were sending in offerings to him, his (the *Roko's*) contribution was a "long pig"—i. e., a human body. He and the missionary, he said, have met since and discussed—I mean, talked over—this practical joke. He invited me in the evening to a *mekké*—i. e., *soirée musicale*. The singing was a weird and curious performance, which has a strange fascination. There were about fifty performers, comprising, in fact, the entire party present. One man begins alone, and after he has sung a few bars, another takes it up in a sort of second to him; then a few more join, till suddenly the whole body of voices strike in, accompanying the song with strange, unintelligible gesticulations, turning half round (they are all seated on the ground), and pointing at each other with intent, meaning looks, and occasionally all clapping hands, in absolute unison—the song ending unexpectedly and quite abruptly with one clap. The time is beaten by a man with a couple of small sticks; it was very intricate, and the music evidently genuine and old, unlike anything I ever heard, and not to be rendered by our notation. *Yanggona* followed—a serious ceremonial brew—and I acquitted myself well, emptying the cup at a single draught, the *Roko* afterward presenting me with his own bowl, which was considered a great compliment.

Having asked Sailosi, the provincial scribe, a very nice fellow, whether I could see some national dancing, I was told that it would hardly be worth my while, as there were only girls here to dance. I, of course, protested against this "only" as not merely ungallant but inapplicable, so far as my tastes were concerned; but it turned out that the scribe knew best, for the young ladies' performance was not very interesting, and it was very long. A few of the smaller girls, with a *lali* or drum, formed a group, while

the rest in one or two rows kept walking slowly round them, singing in admirable time, far better than usually in church or school, but quite monotonous as to tune. Their costume was only the simple *sulu* or waist-cloth, but there were no really beautiful figures among them. Little bonfires were made to light up the performance, and the groups of small children tending these, or improvising torches, which they held with the greatest gravity and patience, was the most picturesque part of the scene. At last, when the young ladies had evidently exhausted their *répertoire*, and were beginning to repeat themselves, I slipped away, when Sailosi followed and begged me to stay, as he had arranged for a men's dance, and it was just coming on. Accordingly, they arrived and took possession of the ground; and the girls, after walking and chanting round them for a minute or two, as if by way of protest, gave it up and seated themselves among the spectators. It must be admitted that the new performance was a very superior affair. The dancers, fine stalwart fellows, gave first some of those curious combined movements, either simultaneous and in marvelous unison, or sometimes passing down a long line as if to represent the motion of a wave: then there were some capital figures, vigorously and beautifully danced, alternate rows dancing with regular steps in opposite directions, then setting to each other and wheeling round. I should not venture in "Maga," or indeed elsewhere, to hint that it was an improvement on a reel, but it recalled one in many of its features, including the occasional shout.

At Naiserelangi, another town on the north coast, where a half-yearly assemblage of chiefs was sitting, I had the good fortune to see some very picturesque and interesting ceremonies. These consisted of the customary offerings made by the people of the neighborhood to the visitors who had come from other parts of the district. Groups of these—splendid-looking fellows many of them—sat squatting in expectation on a space near the chief's house; while down the various paths leading to the village picturesque files of men and women came streaming on, carrying, either in their hands or on poles slung over their shoulders, bunches of every size of yams, or *dalo*, or pigs, or turtles. The procession had certainly not been marshaled with a conscious eye to the picturesque, and yet no artist or stage-manager could have produced an effect more perfect as to grouping, form, and color—the long rows of pleasant or stalwart figures ending off with little children, each gravely carrying its little offering, a single fruit, perhaps, or an egg; while for background to the picture rose a gently sloping hill-side, half wild, half planted, and crowned by precipice and forest. The bearers came up and deposited their burdens before the party of visitors, some one of these laying his hand on each heap in token of acceptance; and then followed a

gentle clapping of hands, or of some other naked part, either in unison or a sort of running fire, but in a quiet ceremonious manner, as indicating formal rather than enthusiastic approval. Then the immense heap was divided into portions by a *mata ni vanua* —a hereditary official combining the duties of herald, embassador, and master of the ceremonies—who then proclaimed the name of the place for which each portion was destined. This is obviously a very delicate, not to say critical, operation, and to perform the division to the general satisfaction requires tact and discrimination of a high order. Finally, the parties representing each of the places named stepped forward and carried off their allotted portions. There is considerable feasting on these occasions, and sometimes, with such vast piles of food, considerable waste. They are enormous eaters, and constantly at it. One morning our share of the offering was brought in—a turtle and a mountain of *dalo*, then a little later a pig and another vast heap of *dalo* and yams; and before evening our crew of five had accounted for it all, with the very slight assistance we could give them; but the national vegetables have, of course, very little substance. Sometimes one sees fine-looking poultry and even turkeys, and one often gets very fair fish.

The sea, indeed, in some places, teems with life. You sail through masses of little white jelly-fish, or of a larger brown kind, besides a magnificent species of a rich purple color. Then there are multitudes of a diminutive flying-fish which I have not seen elsewhere. To the usual perils of the deep must here be added the shoals of gar-fish—a creature usually some fifteen inches long, with a long, sharp, bony snout—which at times take to whizzing through the air in all directions. You can not avoid them, for you can not tell from what direction one may be coming, and the snout, if it hit you fair, would go through your face or give a very ugly wound. One of our crew was struck and wounded, but he only threw the fish to the bottom of the boat, and said quietly, "I shall take it out of you for this to-night." A woman in the neighborhood had recently been struck by one in the breast, and died of the wound. A curious sight I saw one day, which I could not understand. Two large fish rose together about a yard from each other, shot straight up into the air, and then, sheering off in opposite directions, fell into the water a long way from each other. I asked what this meant—had they quarreled? "No," said one of the sailors, "it is not that. I have seen it before. It means a fair wind to-morrow." So next day, the wind being the reverse of fair, they put him into the bows to get the benefit of the water as it broke over us—hardly the way to encourage a study of natural phenomena!

The Fijians are a grand-looking race, splendidly made, and well

proportioned from head to foot—no falling away about the calves, or spur-like heels, as one sees in some of the finer Indian races. Then such a carriage—broad shoulders, with the head well set on and thrown back. The mop head of hair, composed of long, separate spirals carefully tended and frizzed out, which is so special a characteristic of the race that till lately it was thought a natural peculiarity of the hair, is now unfortunately going out of fashion. It gives a very imposing appearance to the wearer, like a gigantic Guard's "bear-skin," but is now curtailed to the modest dimensions of four to six or seven inches in length. It is often dyed to a yellowish brown by a weekly plastering with lime, which also stiffens it, and is very becoming, though its primary use is to destroy the superabundant insect colonies. Any actor wishing to acquire the gait of conventional majesty should come out here and watch the ordinary Fijians walking up and down, every inch a king, and, in quaint combination with this majestic strut, holding each other's hands like little children. In color some few are very black, but the great majority vary from a dark bronze to *chocolat Ménier;* and one is often inclined to wonder whether the ancient use of bronze in statuary was suggested by the coloring of some such race. Certainly in this color humanity may go naked and not be ashamed. The costume proper is only the *sulu*, or waist-cloth; and there can be no better proof of the Fijian's natural dignity and look of breeding, than that the too frequent addition of a dirty flannel shirt does not always transform him into a ruffian or a snob. When a black coat and trousers are superadded —happily this is still very rare—as much can not be said!

The mysterious question of a general decline of these races has often been discussed, and has been ascribed to many causes, all of which contribute something, and some of which, as drink and debauchery, are obvious. Hardly less so, perhaps, the going to church in a full suit of European clothes, and sitting naked in a draught to cool themselves afterward! For this reckless introduction of clothing, not less deleterious than unæsthetic, the more ignorant missionary of former days has to answer, and disease has not unfrequently been introduced, besides, in second-hand clothing.

One hopes against hope, and against such experience as one has, that the decline of the Fijians will be arrested. The disappearance from the earth of these very fine races—for the Polynesians are finer still, perhaps the finest-looking race anywhere—is a distinct loss to the world, and not merely from a sentimental or antiquarian point of view. The experiment of preserving such a race has certainly never been tried before under such favorable circumstances, for the workers have had *carte blanche;* but it would not be surprising if, feeling they are fighting a losing bat-

tle, they began now to relax their exertions. It was melancholy to look at the registers of the little towns, neatly kept by native scribes, and to observe the gradual decrease—if fewer deaths sometimes, then also in proportion fewer births. One noticed, too, the hopeless resignation of the sick, suffering from comparatively slight ailments, but apparently not caring to live. If something more could be done in the way of giving skilled attendance to the sick, it would be well. An attempt is being made, by giving some little training in the hospitals, but the hamlets are so numerous, and so small and scattered, that it would be difficult for such trained attendants to reach them all. More might, as it seemed to me, be done in the way of sanitary supervision. The head-man or the district chief may be "responsible," but he may not always understand what is needed. Where sites are unhealthy they should be changed, and far greater cleanliness in the surroundings insisted on. (The interiors of the houses, as I have said, are almost faultless in this respect.) Direct encouragement might be given in some form for the rearing of children. The possession of an illegitimate child being now a proof of a crime which is punishable by law, such children, naturally, seldom see the light. But what I believe is needed, above all, is some additional stimulus to exertion, some interest in life which would strengthen their hold on it. With our accumulated experience, our great resources, and unlimited good intentions, is the problem beyond us?—*Abridged from Blackwood's Magazine.*

THE FOUNDATION-STONES OF THE EARTH.*

By Prof. T. G. BONNEY.

DO we know anything about the earth in the beginning of its history—anything of those rock-masses on which, as on foundation-stones, the great superstructure of the fossiliferous strata must rest? Palæontologists, by their patient industry, have deciphered many of the inscriptions, blurred and battered though they be, in which the story of life is engraved on the great stone book of Nature. Of its beginnings, indeed, we can not yet speak. The first lines of the record are at present wanting—perhaps never will be recovered. But, apart from this: before the grass and herb and tree, before the "moving creature in the water," before the "beast of the earth after his kind," there was a land and there was a sea. Do we know anything of that globe, as yet void of life? Will the rocks themselves give us any

* An address delivered before the British Association for the Advancement of Science, at the Bath meeting, September 10, 1888.

aid in interpreting the cryptogram which shrouds its history, or must we reply that there is neither voice nor language, and thus accept with blind submission, or spurn with no less blind incredulity, the conclusions of the physicist and the chemist? The secret of the earth's hot youth has doubtless been well kept; so well that we have often been tempted to guess idly rather than to labor patiently. Nevertheless, we are beginning, as I believe, to feel firm ground after long walking through a region of quicksands; we are laying hold of principles of interpretation, the relative value of which we can not in all cases as yet fully apprehend —principles which sometimes even appear to be in conflict, but which will some day lead us to the truth. The name Cambrian has been given to the oldest rocks in which fossils have been found. This group forms the first chapter in the first volume, called Palæozoic, of the history of living creatures. Any older rocks are provisionally termed Archæan. These — I speak at present of those indubitably underlying the Cambrian—exhibit marked differences one from another. Some are indubitably the detritus of other, and often of older, materials—slates and grits, volcanic dust and ashes, even lava-flows. Such rocks differ but little from the basement beds of the Cambrian; probably they are not much older, comparatively speaking. But in some places we find in a like position rocks as to the origin of which it is more difficult to decide. Often in their general aspect they resemble sedimentary deposits, but they seldom retain any distinct indications of their original fragmental constituents. They have been metamorphosed, the old structures have been obliterated, new minerals have been developed, and these exhibit that peculiar orientation, that rudely parallel arrangement which is called foliation. That these rocks are older than the Cambrian can often be demonstrated. Sometimes it can even be proved that their present distinctive character had been assumed before the overlying Cambrian rocks were deposited. Such rocks, then, we may confidently bring forward as types of the earth's foundation-stones. I must assume what I believe few, if any, competent workers will deny, that certain structures are distinctive of rocks which have solidified from a state of fusion under this or that environment; others are distinctive of sedimentary rocks; others, again, whatever may be their significance, belong to rocks of the so-called metamorphic group. Our initial difficulty is to find examples of the oldest rocks in which the original structures are still unmodified. Commonly they are like palimpsests, where the primitive character can only be discerned, at best faintly, under the more recent inscription. Here, then, is one of the best which I possess—a Laurentian gneiss from Canada. Its structure is characteristic of the whole group; the crystals of mica or horn-

blende are well defined, and commonly have a more or less parallel arrangement; here and there are bands in which these minerals are more abundant than elsewhere. The quartz and the feldspar are granular in form; the boundaries of these minerals are not rectilinear, but curved, wavy, or lobate; small grains of the one sometimes appear to be inclosed in larger grains of the other. Though the structure of this rock has a superficial resemblance to that of a granite of similar coarseness, it differs from it in this respect, as we can see from the next instance, a true granite, where the rectilinear outline of the feldspar is conspicuous. Here, then, is one of our problems. This difference of structure is too general to be without significance. What, then, does it mean? Among the agents of change known to geologists, three are admittedly of great importance: these are water, heat, and pressure. The first effect of pressure due to great earth-movements is to flatten somewhat the larger fragments in rocks, and to produce in those of finer grain the structure called cleavage. This, however, is a modification mainly mechanical. It consists in a rearrangement of the constituent particles; mineral changes, so far as they occur, being quite subordinate. But in certain extreme instances the latter are also conspicuous. From the fine mud, generally the result of the disintegration of feldspar, a mica, usually colorless, has been produced, which occurs in tiny flakes, often less than one hundredth of an inch long. In this process a certain amount of silica has been liberated, which sometimes augments pre-existing granules of quartz, sometimes consolidates independently as micro-crystalline quartz. Simultaneously carbonaceous and ferruginous constituents are converted into particles of graphite or of iron oxide. As to the effects of pressure when it acts upon a rock already crystalline, there are, as it seems to me, differences in the resultant structures which are dependent upon the mode in which pressure has acted. They are divisible into two groups; one indicating the result of simple direct crushing, the other of crushing accompanied by shearing. In the former case, the rock-mass has been so situated that any appreciable lateral movement has been impossible; it has yielded like a block in a crushing-machine. In the latter, a differential lateral movement of the particles has been possible, and it has prevailed when (as in the case of an overthrust fault) the whole mass has not only suffered compression, but also has traveled slowly forward. Obviously, the two cases can not be sharply divided, for the crushing up of a non-homogeneous rock may render some local shearing possible. Still, it is important to separate them in our minds, and we shall find that in many cases the structure, as a whole, like the cleavage of a slate, results from a direct crush; while in others the effects of shearing predominate. The latter, accordingly, ex-

hibit phenomena resembling the effects of a tensile stress. Materials of a like character assume a more or less linear arrangement; the rock becomes slightly banded, and exhibits, as has been said, a kind of flexion structure. The mass gradually assumes a fragmental condition under the pressure, and its particles, as they shear and slide under the effects of thrust, behave to some extent like those of a non-uniform mass of rock in a plastic condition, as, for example, a slaggy glass. Illustrations of the effects of direct crushing in a granitoid rock are common in the Alps. Those of a shearing crush are magnificently developed near the great overthrust faults in the northwest Highlands of Scotland. It seems, then, to be demonstrated that by mechanical deformation, accompanied or followed by molecular rearrangement, foliated rocks, such as certain gneisses and certain schists, can be produced from rocks originally crystalline. But obviously there are limits to the amount of change. To get certain results you must have begun with rocks of a certain character. Hitherto we have been dealing with rocks which were approximately uniform in character, though composed of diverse materials—that is, with rocks more or less granular in character. Suppose, now, the original rock to have already acquired a definite structure—suppose it had assumed, never mind how, a distinct mineral banding, the layers varying in thickness from a small fraction of an inch upward. Would this structure survive the mechanical deformation? I can give an answer which will at any rate carry us a certain way. I can prove that subsequent pressure has frequently failed to obliterate an earlier banded structure. In such a district as the Alps we commonly find banded gneisses and banded schists which have been exposed to great pressure. Exactly as in the former case, the new divisional planes are indicated by a coating of films of mica, by which the fissility of the rock in this direction is increased. The mass has assumed a cleavage-foliation. I give it this name because it is due to the same cause as ordinary cleavage, but is accompanied by mineral change along the planes of division, while I term the older structure stratification-foliation, because so frequently, if it has not been determined by a stratification of the original constituents, it is at any rate a most extraordinary imitation of such an arrangement. In many cases the new structure is parallel with the old; but in others, as in the "strain-slip" cleavage of a phyllite, the newer can be seen distinctly cutting across the older mineral banding. To put it briefly, I assert, as the result of examining numbers of specimens, that, though in certain cases the new structure is dominant, a practiced eye seldom fails to detect traces of the older foliation, while in a large number of instances it is still as definite as the stripe in a slate. We have got, then, thus far—that pressure acting on rocks pre-

viously crystallized can produce a foliation; but when it has acted in Palæozoic or later times, the resulting structures can be identified, and these, as a rule, are distinguishable from those of the most ancient foliated rocks, while at present we have found no proof that pressure alone can produce any conspicuous mineral banding. I am aware that this statement will be disputed, but I venture to state, as one excuse for my temerity, that probably few persons in Great Britain have seen more of crystalline rocks, both in the field and with the microscope, than myself. So, while I do not deny the possibility of a well-banded rock being due to pressure alone, I unhesitatingly affirm that this at present is a mere hypothesis—a hypothesis, moreover, which is attended by some serious difficulties. For, if we concede that, in the case of many rocks originally granular, dynamic metamorphism has produced a mineral banding, this is only on a very small scale; the layers are but a small fraction of an inch thick. No one could for a moment confuse a sheared granite from the Highlands with a Laurentian gneiss from Canada or with an uninjured Hebridean gneiss. For the former to attain to the condition of the latter, the mass must have been brought to a condition which admitted of great freedom of motion among the particles—almost as much, in short, as among those of a molten rock. Clearly the dynamic metamorphism of Palæozoic or later ages appears to require some supplementary agency. Can we obtain any clew to it? I have already mentioned the effect produced by the intrusion of large masses of igneous rocks upon other rocks. These may be either igneous rocks already solidified or sedimentary rocks. The former may be passed over, as they will not materially help us. In regard to the latter, the results of contact-metamorphism, as it is called, as we might expect, are very various. Speaking only of the more extreme, we find that sandstones are converted into quartzites; limestones become coarsely crystalline, all traces of organisms disappearing and crystalline silicates being formed. In clayey rocks all signs of the original sediments disappear, crystalline silicates are formed, such as mica (especially brown) garnet, andalusite, and sometimes tourmaline; feldspar, however, is very rare. Fair-sized grains of quartz appear, either by enlargement of original granules or by independent crystallization of residual silica. It is, further, important to notice that, as we approach the surface of the intrusive mass—that is, as we enter upon the region where the highest temperature has been longest maintained—the secondary minerals attain a larger size and are more free from adventitious substances—that is, they have not been obliged, as they formed, to incorporate pre-existing constituents. The rock, indeed, has not been melted down, but it has attained a condition where a rather free molecular movement became possible, and a new min-

eral in crystallizing could, as it were, elbow out of the way the more refractory particles. Its effects are, in brief, to consolidate the rock, and, while causing some constituents to vanish, to increase greatly the size of all the others. It follows, then, that mineral segregation is promoted by the maintenance for some time of a high temperature, which is almost a truism. I may add to this that, though rocks modified by contact-metamorphism differ from the Archæan schists, we find in them the best imitations of stratification-foliation, and of other structures characteristic of the latter. One other group of facts requires notice before we proceed to draw our inferences from the preceding. Very commonly, when a stratified mass rests upon considerably older rocks, the lower part of the former is full of fragments of the latter. Let us restrict ourselves to basement beds of the Cambrian and Ordovician—the first two chapters in the stone-book of life. What can we learn from the material of its pages? They tell us that granitoid rocks, crystalline schists of various kinds, as well as quartzites and phyllites, then abounded in the world. The Torridon sandstone of Scotland proves that much of the subjacent Hebridean had even then acquired its present characteristics. The Cambrian rocks of North and South Wales repeat the story, notably near Llynfaelog in Anglesey, where the adjacent gneissoid rocks from where the pebbles were derived, even if once true granites, had assumed their present differences before the end of the Cambrian. By the same time similar changes had affected the crystalline rocks of the Malverns and parts of Shropshire. It would be easy to quote other instances, but these may suffice. I will only add that the frequent abundance of slightly altered rocks in these conglomerates and grits seems significant. Such rocks seem to have been more widely distributed—less local—than they have been in later periods. Another curious piece of evidence points the same way. In North America, as is well known, there is a great group of rocks to which Sir W. Logan gave the name of Huronian, because it was most typically developed in the vicinity of Lake Huron. Gradually great confusion arose as to what this term really designated. But now, thanks to our fellow-workers on the other side of the Atlantic, the fogs, generated in the laboratory, are being dispelled by the light of microscopic research and the fresh air of the field. We now know that the Huronian group in no case consists of very highly altered rocks, though some of its members are rather more changed than is usual with the British Cambrians, than which they are supposed to be slightly older. Conglomerates are not rare in the Huronian. Some of these consist of granitoid fragments in a quartzose matrix. We can not doubt that the rock was once a pebbly sandstone. Still, the matrix, when examined with the microscope,

differs from any Palæozoic sandstone or quartzite that I have yet seen. Among grains of quartz and feldspar are scattered numerous flakes of mica, brown or white. The form of these is so regular that I conclude they have been developed, or at least completed, *in situ*. Moreover, the quartz and the feldspar no longer retain the distinctly fragmental character usual in a Palæozoic grit, but appear to have received secondary enlargement. A rock of fragmental origin to some extent has simulated or reverted to a truly crystalline structure. In regard to the larger fragments we can affirm that they were once granitoid rock, but in them also we note incipient changes, such as the development of quartz and mica from feldspar (without any indication of pressure), and there is reason to think that these changes were anterior to the formation of the pebbles. To sum up the evidence: In the oldest gneissoid rocks we find structures different from those of granite, but bearing some resemblance to, though on a larger scale than, the structures of vein-granites or the surfaces of larger masses when intrusive in sedimentary deposits. We find that pressure alone does not produce structures like these in crystalline rocks, and that when it gives rise to mineral banding this is only on a comparatively minute scale. We find that pressures acting upon ordinary sediments in Palæozoic or later times do not produce more than colorable imitations of crystalline schists. We find that when they act upon the latter the result differs, and is generally distinguishable from stratification-foliation. We see that elevation of temperature obviously facilitates changes and promotes coarseness of structure. We see also that the rocks in a crystalline series which appear to occupy the highest position seem to be the least metamorphosed, and present the strongest resemblance to stratified rocks. Lastly, we see that mineral change appears to have taken place more readily in the later Archæan times than it ever did afterward. It seems, then, a legitimate induction that in Archæan times conditions favorable to mineral change and molecular movement—in short, to metamorphism—were general, which in later ages have become rare and local, so that, as a rule, these gneisses and schists represent the foundation-stones of the earth's crust. On the other side, what evidence can be offered? In the first place, any number of vague or rash assertions. So many of these have already come to an untimely end, and I have spent so much time and money in attending their executions, that I do not mean to trouble about another till its advocates express themselves willing to let the question stand or fall on that issue. To a geologist (especially one belonging to the school of Lyell) it is equally difficult to conceive that there should be a broad distinction between the metamorphic rocks of Archæan and post-Archæan age respectively, as that the pre-Tertiary vol-

canic rocks should be altogether different in character from those of Tertiary and recent times. During the periods mentioned volcanic rocks appear, as we should expect, to have been ejected from beneath the earth's crust similar in composition and condition, and to have solidified with identical environment. Hence the results, allowing for secondary changes, should still be similar. But to assume that the environment of a rock in early Archæan times was identical with that of similar material at a much later period is to beg the whole question. My creed also is the uniformitarian, but this does not bind me to follow a formula into a position which is untenable. "The weakness and the logical defect of uniformitarianism" (these are Prof. Huxley's words) "is a refusal, or at least a reluctance, to look beyond the 'present order of things,' and the being content for all time to regard the oldest fossiliferous rocks as the *ultima Thule* of our science." Now, speaking for myself, I see no evidence since the time of these rocks, as at present known, of any very material difference in the condition of things on the earth's surface. The relations of sea and land, the climate of regions, have been altered; but because I decline to revel in extemporized catastrophes, and because I believe that in nature order has prevailed and law has ruled, am I therefore to stop my inquiries where life is no longer found, and we seem approaching the first-fruits of the creative power? Because palæontology is perforce silent; because the geologist can only say, "I know no more," must I close my ear to those who would turn the light of other sciences upon the dark places of our own, and meet their reasoning with the exclamation, "This is not written in the book of uniformity"? To do this would be to imitate the silversmiths of old, and silence the teacher by the cry, "Great is Diana of the Ephesians!" What, then, does the physicist tell us was the initial condition of this globe? I will not go into the vexed question of geological time, though, as a geologist, I must say that we have reason to complain of Sir W. Thomson. Years ago he reduced our credit at the bank of time to a hundred million years. We grumbled, but submitted, and endeavored to diminish our drafts. Now he has suddenly put up the shutters, and declared a dividend of less than four shillings in the pound. I trust some aggrieved shareholder will prosecute the manager. While personally I see little hope of arriving at a chronological scale for the age of this earth, I do not believe in its eternity. What, then, does the physicist tell us must have been in the beginning? I pass to the *consistentior status* of Leibnitz, when the molten globe had crusted over, and its present history began. Rigid uniformitarian though you may be, you can not deny that, when the very surface of the ground was at a temperature of at least 1,000° Fahr., there was no rain, save of glowing

ashes—no river, save of molten fire. Now is ending a long history with which the uniformitarian must not reckon—of a time when many compounds now existing were not dissolved but dissociated, for combination under that environment was impossible. Yet there was still law and still order—nay, the present law and order may be said even then to have had a potential existence; nevertheless, to the uniformitarian gnome, had such there been, every new combination of elements would have been a new shock to his faith, a new miracle in the earth's history. But at the times mentioned above, though oxygen and hydrogen could combine, water could not yet rest upon the ruddy crust of the globe. What does that mean? This, that assuming the water of the ocean equivalent to a spherical shell of the earth's radius and two miles thick, the very lava-stream would consolidate under a pressure of about 310 atmospheres, equivalent to nearly 4,000 feet of average rock. Let us pass on to a time, which, according to Sir W. Thomson, would rather quickly arrive, when the surface of the crust had cooled by radiation to its present temperature. Let us merely, for illustration, take a surface temperature of 50° F. (nearly that of London), and assume that the present rise of crust temperature is 1° F. for every fifty feet of descent, which is rather too rapid. If so, 212° F. is reached at 8,100 feet, and 250° F. at 10,000 feet. Though the latter temperature is far from high, yet we should expect that, under such a pressure, chemical changes would occur with much more facility than at the surface. But many Palæozoic, or even later rock-masses, can now be examined which at a former period of their history have been buried beneath at least 10,000 feet of sediment, yet the alteration of their constituents has been small; only the more unstable minerals have been somewhat modified, the more refractory are unaffected. But for a limited period after the *consistentior status*, the increase of crust temperature in descending would be far more rapid; when one twenty-fifth of the whole period from that epoch to the present had elapsed—and this is no inconsiderable fraction—the rate of increase would be one degree for every ten feet of descent. Suppose, for the sake of comparison, the surface temperature as before, the boiling-point of water would be reached at 1,620 feet, and at 10,000 feet, instead of a temperature of 250° F., we should have one of 1,050° F. But, at the latter temperature, many rock-masses would not be perfectly solid. According to Sorby, the steam cavities in the Ponza trachyte must have formed, and thus the rock have been still plastic at so low a temperature as 680° F. At this period, then, the end of the fourth year of the geological century, structural changes in igneous and chemical changes in sedimentary rocks must have taken place with greater facility than in any much later period in the world's history. Then a temperature of

2,000° F., sufficient to melt silver—more than sufficient to melt many lavas—would have been reached at a depth of about four miles. It would now be necessary to descend for at least forty miles in order to arrive at this zone. During the ninety-six years of the century it has been changing its position in the earth's crust, more slowly as time went on, from the one level to the other. There is another consideration. In very early times, as shown by Prof. Darwin and Mr. Davison, the zone in the earth's crust at which lateral thrust ceases and tension begins must have been situated much nearer to the surface than at present. If now, at the end of the century, it is at the depth of five miles, it was at the end of the fourth year at a depth of only one mile. Then, a mass of rock, ten thousand feet below the surface, would be nearly a mile deep in the zone of tension. Possibly this may explain the mineral banding of much of our older granitoid rock, already mentioned, and the coincidence of foliation with what appears to be stratification in the later Archæan schists, as well as the certainly common coincidence of microfoliation with bedding in the oldest indubitable sediments. Pressure, no doubt, has always been a most important factor in the metamorphism of rocks; but there is, I think, at present some danger in overestimating this, and representing a partial statement of truth as the whole truth. Geology, like many human beings, suffered from convulsions in its infancy; now, in its later years, I apprehend an attack of pressure on the brain. The first deposits on the solidified crust of the earth would obviously be igneous. As water condensed, denudation would begin, and stratified deposits, mechanical and chemical, become possible, in addition to detrital volcanic material. But at that time the crust itself, and even stratified deposits, would often be kept for a considerable period at a temperature similar to that afterward produced by the invasion of an intrusive mass. Thus, not only rocks of igneous origin (including volcanic ashes) would predominate in the lowest foundation-stones, but also secondary changes occur more readily, and even the sediments or precipitates should be greatly metamorphosed. Strains set up by a falling temperature would produce, in masses still plastic, banded structures, which, under the peculiar circumstances, might occur in rocks now coarsely crystalline. As time went on, true sediments would predominate over extravasated materials, and these would be less and less affected by chemical changes, and would more and more retain their original character. Thus, we should expect that as we retraced the earth's course through "the corridor of time," we should arrive at rocks which, though crystalline in structure, were evidently in great part sedimentary in origin, and should beyond them find rocks of more coarsely crystalline texture and more dubious character, which,

however, probably were in part of a like origin; and should at last reach coarsely crystalline rocks, in which, while occasional sediments would be possible, the majority were originally igneous, though modified at a very early period of their history. This corresponds with what we find in nature, when we apply, cautiously and tentatively, the principles of interpretation which guide us in stratigraphical geology. I have stated as briefly as possible what I believe to be facts. I have endeavored to treat these in accordance with the principles of inductive reasoning. I have deliberately abstained from invoking the aid of "deluges of water, floods of fire, boiling oceans, caustic rains, or acid-laden atmospheres," not because I hold it impossible that these can have occurred, but because I think this epoch in the earth's history so remote and so unlike those which followed that it is wiser to pass it by for the present. But, unless we deny that any rocks formed anterior to or coeval with the first beginning of life on the globe can be preserved to the present time, or, at least, be capable of identification—an assumption which seems to me gratuitous and unphilosophical—then I do not see how we can avoid the conclusion to which we are led by a study of the foundation-stones of the earth's crust—namely, that these were formed under conditions and modified by environments which, during later geological epochs, must have been of very exceptional occurrence. If, then, this conclusion accords with the results at which students of chemistry and students of physics have independently arrived, I do not think that we are justified in refusing to accept them because they lack the attractive brilliancy of this or that hypothesis, or do not accord with the words in which a principle, sound in its essence, has been formulated. It is true in science, as in a yet more sacred thing, that "the letter killeth, the spirit giveth life."

NATURAL SCIENCE IN ELEMENTARY SCHOOLS.*

By J. M. ARMS.

THE question before the educators of our country is a practical one, involving important and far-reaching results. Shall science lessons be given in elementary schools? It is a question which can be answered affirmatively or negatively only by considering *why* and *how* such lessons shall be given. What I have to say on the subject will be more practical than theoretical, as whatever views I hold are based wholly upon ten years' experience in teaching natural science to young people from five to twenty years of age. This being the case, my remarks must be necessarily more personal than I would wish.

* Read at the "National School of Methods," Saratoga, August, 1888.

Beginning to teach with no preconceived notions as to the practical results obtainable, but with a love for the science of Nature, and a strong desire to make our boys and girls love it also, I soon found out that science lessons were not only helpful in the way of awakening interest, but also invaluable in the way of disciplining the mind. Little children came to me with untrained eyes, hands, and brains; this I expected, and therefore was not surprised; but boys and girls from fifteen to twenty years of age came in a worse condition, and this was unexpected. Not only were their eyes and hands untrained, but their brains were in a pathological condition which rendered independent thinking impossible. The number of my pupils increasing, and their ages ranging, as I have said, from five to twenty years, I had an excellent opportunity for comparing the quality of work done by older and younger pupils, also by pupils whose perceptive faculties had been trained in early life, and those who had not received this training. The inferences I was forced to draw from these comparisons set me to thinking seriously. The inaccuracy of the observational and manual work done by older pupils, the indefiniteness of expression, the lack of system, and the inability to do comparative and inferential work, were so many revelations of the true aims of science teaching. The absolute necessity for accuracy in every study and every department of work made *accuracy* the first object to be attained in every science lesson; the vagueness of the oral and written statement made *clear, concise expression* the second object. The want of method emphasized the need of *a simple, orderly grouping of the observations*, while the painful and fruitless attempts to make comparisons and draw inferences showed the necessity of cultivating *the power of generalizing from specific facts.*

The objects of elementary science work in this way became clear to me. As time passed, I was convinced that the first two aims might be realized with children of primary-school age; the last two, in greater or less degree, with scholars of grammar and high school age, *provided they had received the preparatory training of the primary school.* In attempting to realize these aims I strove to apply constantly the scientific or "natural method" of teaching, and, though applying it far from perfectly, I could see that in more skillful hands than my own its successful application would result in that which was most desirable, *the development of the child.*

Gradually the opinion grew and strengthened, till it has now become a conviction, that those children who have been trained by the "natural method," from five to thirteen years of age, do better work at thirteen than those who have not received this training do from fifteen to twenty years of age. Their work is

better because it is marked by greater accuracy, greater ability in mechanical execution, and stronger power of reasoning. It proves, in brief, that the doers of it are active and creative rather than passive and imitative.

The recognition of the truth of these statements, of the importance of the objects to be accomplished, and of the value of studies which promote their accomplishment in a pre-eminent degree, answers the question, Why shall science lessons be given in elementary schools?

The question, How shall these lessons be given? is one which demands immediate and serious consideration. Uncertainty prevails in the minds of teachers, and confusion in the general mind, on this subject. Oral and language lessons are often mistaken for science lessons, although usually the three have distinctly different objects. Judging from the many courses of study I have been privileged to examine the past year, I conclude that the oral lesson, *as generally given*, aims to interest the young. Whatever common objects happen to be at hand are used for the purpose, and the success of the lesson depends largely upon the animation and versatility of the teacher and the receptivity of the class. In order to make this oral lesson a science lesson, the objects observed must be selected in a natural sequence; the teacher must be logical in questioning, whether or not she be graphic in description, while the pupils must be independent seekers for knowledge rather than active or passive receptacles of information. I do not say the oral lesson can not be a science lesson, but that oral lessons, as generally given, are not science lessons.

The language lesson aims at the use of good language, at correct grammatical construction, spelling, and punctuation. Clear, concise expression may be one object of the language lesson, but it must be remembered that this is not the first object of the science lesson.

The question, How shall science lessons be given? can best be answered by keeping constantly in mind the aims of science work. Whatever helps to realize these, helps to answer the question, as the ways and means must be adapted to the end in view.

In giving observation lessons upon plants, animals, and minerals, which, here let me say, are elementary science lessons as well as those that have received this name in our prescribed courses of study, three conditions must obtain: First, the children must be provided with specimens; second, the school must be under the control of the teacher; third, the lesson must be prepared by the teacher in the form of questions which lead step by step from the simple to the more difficult. It is evident, if the pupils are to be provided with specimens of animals, that only the smaller and simpler ones can be used, such as the star-fish, sea-

urchin, or snail. In many of our schools the lessons on animals begin with the dog, cat, or bird. Ten years ago it was almost a necessity to begin in this way; it is not so to-day. I once began a course of lessons with these familiar but extremely complex animals, and noted the results with interest. Before the course was finished, I had given up practically the four objects I aimed to accomplish. I was so thoroughly convinced that the habit of accurate observation could not be acquired by children with one specimen in the hand of the teacher, or one picture hung upon the wall, that I never repeated the experiment. I regret now that I did not preserve some of the written work of this class, but it seemed so worthless, as compared with that done by children of the same age who had begun their lessons with the simpler animals, that I did not keep any of it for future reference. When the class numbers fifty or sixty children, those in the back part of the school-room can not see the bird or kitten distinctly, more or less disorder prevails, and disorder always causes the premature death of science work. If the children come to the desk to examine the specimen, time is lost in going to and from the seat, especially by those whose besetting weakness is laziness, while the moments for observation at the desk must be extremely brief. Close, accurate observation of a specimen in the hand of a child develops patience, and cultivates the habit of mental equilibrium or concentration of mind for twenty or thirty minutes, as may seem desirable, which is of incalculable value.

The second condition of successful science work, namely, a well-governed school, is obviously one condition for all successful school-work. The temptation to whisper and be disorderly, caused, possibly, at first by the use of specimens, will soon be overcome if the children understand that no science lesson can be given till order is preserved. The unruly members of the class are usually the first ones to yield, as these are generally more fond of nature than of books. Many instances could be given, proving most happily the invaluable aid given by science lessons to the teacher in the discipline of lawless children.

While the first two conditions depend for their realization upon both teacher and pupils, the third depends wholly upon the teacher. All preparation must be made *before*, not during the lesson. The questions must be so arranged that each lesson must be a natural growth, a development from the simple to the complex. This method of questioning is the peculiar characteristic of the true science lesson, distinguishing it from the commonly accepted oral and language lesson. Furthermore, each lesson should be related, so to speak, to the lessons that precede and follow it. It can not exist as an isolated thing, but must form an important part of one complete course.

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The question, How shall science lessons be given? can best be answered by keeping constantly in mind the aims of science work. Whatever helps to realize these, helps to answer the question, as the ways and means must be adapted to the end in view.

In giving observation lessons upon plants, animals, and minerals, which, here let me say, are elementary science lessons as well as those that have received this name in our prescribed courses of study, three conditions must obtain: First, the children must be provided with specimens; second, the school must be under the control of the teacher; third, the lesson must be prepared by the teacher in the form of questions which lead step by step from the simple to the more difficult. It is evident, if the pupils are to be provided with specimens of animals, that only the smaller and simpler ones can be used, such as the star-fish, sea-

urchin, or snail. In many of our schools the lessons on animals begin with the dog, cat, or bird. Ten years ago it was almost a necessity to begin in this way; it is not so to-day. I once began a course of lessons with these familiar but extremely complex animals, and noted the results with interest. Before the course was finished, I had given up practically the four objects I aimed to accomplish. I was so thoroughly convinced that the habit of accurate observation could not be acquired by children with one specimen in the hand of the teacher, or one picture hung upon the wall, that I never repeated the experiment. I regret now that I did not preserve some of the written work of this class, but it seemed so worthless, as compared with that done by children of the same age who had begun their lessons with the simpler animals, that I did not keep any of it for future reference. When the class numbers fifty or sixty children, those in the back part of the school-room can not see the bird or kitten distinctly, more or less disorder prevails, and disorder always causes the premature death of science work. If the children come to the desk to examine the specimen, time is lost in going to and from the seat, especially by those whose besetting weakness is laziness, while the moments for observation at the desk must be extremely brief. Close, accurate observation of a specimen in the hand of a child develops patience, and cultivates the habit of mental equilibrium or concentration of mind for twenty or thirty minutes, as may seem desirable, which is of incalculable value.

The second condition of successful science work, namely, a well-governed school, is obviously one condition for all successful school-work. The temptation to whisper and be disorderly, caused, possibly, at first by the use of specimens, will soon be overcome if the children understand that no science lesson can be given till order is preserved. The unruly members of the class are usually the first ones to yield, as these are generally more fond of nature than of books. Many instances could be given, proving most happily the invaluable aid given by science lessons to the teacher in the discipline of lawless children.

While the first two conditions depend for their realization upon both teacher and pupils, the third depends wholly upon the teacher. All preparation must be made *before*, not during the lesson. The questions must be so arranged that each lesson must be a natural growth, a development from the simple to the complex. This method of questioning is the peculiar characteristic of the true science lesson, distinguishing it from the commonly accepted oral and language lesson. Furthermore, each lesson should be related, so to speak, to the lessons that precede and follow it. It can not exist as an isolated thing, but must form an important part of one complete course.

The course on animals for primary schools, as given in our first lesson, begins with the star-fish, and takes up in succession the following subjects: The sea-urchin; the star-fish and sea-urchin compared; the earth-worm; a bivalve shell (*Cyprina*); clam-shell; oyster-shell; clam- and oyster-shell compared; living snail; snail-shell; miscellaneous shells, including pearly nautilus; simple classification of shells; lobster or crayfish; crab; lobster and crab compared; habits of crabs; locust; young living dragon-fly; beetle; butterfly; life-history of butterfly; moth and life-history; bees and their habits; insects in general.

This course covers twenty weeks, devoting two hours a week to the subject. In a general way it may be stated, though of course there is no inflexible rule in regard to time, that the first hour is given to the observation and drawing of the specimen, the first fifteen minutes of the second hour to a review of the observations already made, the following thirty minutes to a written description of the specimen, and the last fifteen minutes to a talk about the habits of the animal. If the habits are discussed before the written work is done, the results are not as good, for the reason that it is much easier for children to describe vaguely the habits of animals than to give accurate, concisely stated observations. In almost every case (excepting, perhaps, two or three animals repugnant to many children, as, for instance, the earth-worm and spider) the teacher will obtain the most satisfactory results by taking structure first and habits afterward. In the primary course no alcoholic specimens are used, but living animals when possible and dried specimens.

The course for grammar schools begins with the horny sponge, and includes the following subjects: Silica sponge (*Geodia*); horny and silica sponge (*Chalina*); sponges compared; a simple animal (*Hydra*); sea-anemone; coral animal (*Galaxea*); sea-anemone and coral animal compared; corals (*Madrepore, fan coral*); star-fish and sea-urchin compared; earth-worm and salt-water worm (*Nereis*) compared; clam- and oyster-shell compared; snail and pearly nautilus; habits of salt- and fresh-water mollusks; lobster or crayfish; crab and barnacle; lobster; crab and barnacle compared; spiders; habits of spiders; locust and larva; dragon-fly and larva; locust and dragon-fly compared; squash-bug and larva; review insects with direct or "incomplete" metamorphosis; butterfly and caterpillar; beetle and grub; fly and maggot; bees; simple classification of insects.

In this course dried, alcoholic, and living specimens are used. The course may be given in twenty weeks, or forty hours, provided the children have gone through the primary course; otherwise, it can not be given, as good comparative work can only be done after accurate observational and descriptive work.

These two elementary courses lay a strong foundation for the high-school course, and also pave the way to the intelligent study of vertebrate life, while the three courses—primary, grammar, and high—furnish a valuable preparation for the advanced biological studies of our scientific schools and colleges. There has been much discussion in our leading journals of late in regard to the teaching of biology in the higher institutions of learning. What to teach and how to teach it have been pressing questions. Courses of study have been proposed which certainly have been ideal for ideal students, but which have almost wholly overlooked the important fact that the majority of the young men and women who are to take these courses have never learned the A, B, C of science work. Many professors, dissatisfied with the poor results obtained, have recognized the chief cause, and asserted that "the college instructor must still regard the student who studies under him as a school-boy whose capacity for observing and investigating natural objects has been blunted by a one-sided course of instruction at school." * In other words, the college is forced to do preparatory work. This the college ought never to do. Preparatory work belongs to preparatory schools. A young man or woman at eighteen ought to be fitted to enter upon an industrial career or upon a scientific or classical course of study, as individual taste or necessity dictates, with hands trained to do a little manual work well, with eyes keen-sighted enough to see things as they are, and with brains capable of thinking upon these things independently.

I have outlined in brief a primary and grammar-school course upon animals. I have been aided in the preparation of these courses by the "Guides for Science Teaching," Nos. III–VII, by Prof. Alpheus Hyatt. Prof. Crosby's "Science Guide," No. XII, and Mrs. Richards's "Guide," No. XIII, are admirable aids in preparing a course upon our common minerals and rocks. The "Science Guide," No. II, by Prof. Goodale, and the well-known works of Prof. Gray, help in adapting the subject of botany to young minds. The present paper is considering the natural rather than the physical sciences, as these "are now generally acknowledged to afford the best means of developing the powers of observation and comparison."

It is impossible to discuss broadly and justly the questions why and how shall science lessons be given in elementary schools without some knowledge of the history of the movement which has given birth to these questions, and also some knowledge of the present status of our schools on the general subject of science teaching. The movement of which we speak the coming century will surely regard as one of the really great movements of our

* See "American Naturalist," June, 1887.

time, so that we may pause here to sketch briefly its origin and growth. After an extended correspondence with superintendents and educators of New England and the West, I may state, with very great certainty, that Boston was the first large city in our country to include systematic lessons upon plants, animals, and minerals in its prescribed course of elementary instruction. This was done in 1877–'78. The movement, however, may be said to have had its origin in the lecture-hall of Louis Agassiz nearly a quarter of a century before. Recognizing the educational and practical value of the study of natural history, and imbued with a broad, humanitarian spirit, Prof. Agassiz invited teachers to attend his lectures before the under-graduates of Harvard. Among those who accepted this invitation was a young woman of whom George B. Emerson wrote, a few years later, "She is the best teacher New England has produced." The truths spoken by the great naturalist *lived* in the brain and heart of Lucretia Crocker till she in her turn was able to inspire the youth of her generation with a love for nature as deep as it was strong. Twenty-five years after the Harvard lectures, Miss Crocker, as supervisor of the public schools of Boston, with the keen judgment of mature womanhood added to the enthusiasm of youth, was advocating with persuasive power a course of elementary instruction which included lessons upon our common plants, animals, and minerals. In 1877–'78 this course was adopted by the school board, and Miss Crocker became supervisor of the natural history work. Surely the inspired words of Agassiz were bearing abundant fruit, though the voice that uttered them was then silent. May we not trust that the harvest-time was known to the sower of the seed?

It soon became evident that the teachers wanted more knowledge of the natural history subjects which they were to teach; and it was then that Miss Crocker found an able helper in Prof. Alpheus Hyatt, who, in the generous spirit of his teacher, Prof. Agassiz, threw the doors of his laboratory wide open to all who wished to come. A "Saturday morning class" was formed. Its members were provided abundantly with specimens for study, and the valuable collections of the Natural History Museum, of which Prof. Hyatt was curator, were freely used in the demonstrations.

The teachers, now as pupils, saw more clearly than ever before the true objects of all science work, namely, the betterment of humanity and the increase of our stock of absolute knowledge. Fortunate indeed are those institutions of learning which number among their professors one who keeps constantly before his pupils these high ideal aims of science! With these aims as ultimate goals, the work of student and teacher becomes more effective, because directed in definite yet ever-broadening channels.

An organization, known throughout New England as the "Teachers' School of Science," had been carried on since 1871 by the liberality of one person, Mr. John Cummings, a patron of the Society of Natural History. The faith of Mr. Cummings in the educational value of nature lessons was constant, as proved by his generous contributions year after year.

In the winter of 1878–'79 the pecuniary responsibility of the "school" was assumed by two Boston ladies, Mrs. Pauline Agassiz Shaw, the daughter of Prof. Agassiz, and Mrs. Augustus Hemenway. Five hundred teachers attended this course of lessons upon the scientific method of teaching applied to the study of our common plants, animals, and minerals. Nearly a hundred thousand specimens were carried into the public schools, and the publication of the series of "Science Guides," to which we have referred, was begun, to aid teachers in their work. A new impetus was given to the movement, and an enthusiasm created which promised much for the future.

Eleven years have passed since nature lessons were embodied in the prescribed elementary course of the Boston schools. What is the position of these and other schools of our country on this subject? Do the leaders of the movement who are living to-day feel a sense of disappointment that the results have not been larger? The growth, it is true, has been slow; yet if those who are oppressed by the truth of this statement would compare the science work done in the schools to-day with that done ten or twenty years ago, they would surely bend to their oars with new courage. That work can be briefly described: the quantity was extremely small, and the quality exceedingly poor.

We are beginning to recognize the fact that science lessons can not exert their legitimate influence so long as they are not included in the prescribed curriculum of study, but depend for their life upon the option of the teacher. I have endeavored to obtain exact information on this subject. In New England there are eighty-seven cities and towns whose schools are provided with a superintendent.* Of these, eight include lessons on plants, animals, or minerals in their prescribed courses of study, under the head of "Observation and Elementary Science Lessons," or of "Plants, Animals, Minerals." Fifteen include such lessons under the head of "Oral Instruction." Eleven take up natural objects in connection with language and geography lessons. Five are revising their courses of study, three of which are including observation lessons. Four have not replied to my letter of inquiry. This leaves forty-four cities and towns whose elementary courses do not include nature lessons.

Personal interviews and correspondence with educators in

* See "List of the School Superintendents," for June, 1888.

many Western and Southern States leads me to say, with considerable certainty, that in none of their primary and grammar schools are science lessons *required*.

These facts and figures represent the work prescribed, not the work actually done. In how many schools where these lessons are required are they given by the scientific method? is a question of the first importance. In how many schools, on the other hand, where the lessons are not required are they systematically given by progressive teachers? Want of sufficient data compels me to leave these questions unanswered for the present.

The picture has another and somewhat brighter side. It may be stated as an indisputable fact that there never has been a time when the interest in the subject was so wide-spread. Educators all over the country are giving it their thoughtful consideration. The "National School of Methods" has offered an excellent opportunity for the past three years for obtaining valuable information. Twenty-one States,* and probably several more, have been represented in the natural history classes.

Teachers of primary, grammar, high, and normal schools have testified to the educational value of nature lessons. Superintendents have expressed their approval of such lessons, and shown an earnest desire to help forward the work. This hearty interest, especially on the part of normal-school teachers, is a guarantee that the growth of the movement will continue to be sure, even though it may be slow. This brings me, in conclusion, to the brief consideration of the causes of this slow growth.

The fundamental cause lies, I believe, in our ignorance of the true value and large possibilities of elementary science work. This ignorance is chargeable in great measure to that one-sided system of education which has long prevailed. Our early training, in fact, unfits us for justly appreciating the objects to be attained. If the great body of teachers in our country to-day could be made to know the full value of natural history lessons in the mental training of the young, I for one do not believe the oft-repeated arguments against this kind of teaching would deter them in the least from undertaking the work. Our primary-school teachers need to know for their own inspiration how much they are helping the grammar-school teachers, and the grammar-school teachers, in their turn, the high-school teachers. When they come into possession of this knowledge, the movement will advance with rapid strides, and the four arguments oftenest urged will be answered by the teachers themselves.

When it is said, "The work is impracticable, because specimens

* Maine, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Virginia, North and South Carolina, Alabama, Kentucky, Louisiana, Indiana, Illinois, Iowa, Wisconsin, Michigan, Minnesota, and Nebraska.

can not be obtained," the teachers will reply: "Several towns have already appropriated ten and twenty dollars for the purchase of natural history collections, and these can be used a number of years. Teachers awakened to the new and beautiful revelations of nature are preserving specimens at the sea-shore and in the country. Children have collected hundreds of specimens which have been used in class work, or have helped to form valuable school cabinets."

When, again, it is said, "Our teachers have not been trained by the 'natural method'; how, then, can you expect them to teach by it?" they will answer: "We know from experience the defects of the old methods; is it not possible, then, for us to shun these defects, and to teach by better, more effective methods? The fossilization of teachers is not in order. We must grow, for growth is the necessity, if not the charm, of the teacher's life of to-day."

Again, when it is said, "Too much observational work results in lack of mental concentration and in weak power of memorizing," they will assert: "The time for considering the results of 'too much observational work' has not yet come, nor is the danger so imminent as to concern us now. The criticism offered may be true of much poor oral instruction which 'entertains' children, but it can not be true of elementary science work, the very soul of which finds verbal expression in the words individual effort—such effort as is only possible when the mental faculties are under control."

It is true the mission of the science lesson is not to strengthen the memory. The studies of literature and language do this, while the science lesson quickens the perceptive faculties and cultivates the power of delicate discrimination and of just generalization.

Finally, when it is urged that "the object of this teaching is to make naturalists of our children," they will emphasize the fact that while the object of advanced biological teaching may be to make specialists of those who have an aptitude for this work, the object of *elementary* science work must be, always and ever, the training of the young mind. We are just beginning to find out that a one-sided system of education is not sufficient for our many-sided human nature. We are not all born to be teachers, or professors of law or medicine; we have among us natural mechanics, merchants, inventors, investigators; and a system of instruction which is not broad enough to train these for a life of productive industry falls far short of what it ought to do. Education must have its industrial and scientific as well as its classical side, and not until it does will each child realize its own bright possibility of a better and more enlightened humanity.

THE ARYANS IN SCIENCE AND HISTORY.

By HORATIO HALE.

FROM the Bay of Bengal westward, through northern India, Afghanistan, Beloochistan, Persia, Armenia, Asia Minor, and on through Europe to its farthest bounds—and thence, in modern times, crossing the Atlantic and spreading over both Americas—one great linguistic family occupies a vaster space, peopled by a larger number of famous and powerful nations, than belong to any other ethnic kindred. But this pre-eminence of the Indo-European stock has not always existed. There was a period in the early history of the civilized world when the Hamito-Semitic family was more widely diffused than any other; and at a later time, when the Arabian empire stretched from India to Spain, this preponderance seemed to be restored. Even in our day the Chinese language and literature are probably spoken and read by a larger population than is claimed by any other race. But there can be no question that during the last two centuries the communities speaking languages of the first-named family, or at least some among them, have been the dominant nations of the globe.

In the brief term of less than a century which has elapsed since the connections and limits of this great family have been ascertained, various designations have been applied to it—Indo-European, Indo-Germanic, Indo-Celtic, Aryan. The latter name, being the least cumbrous, is gradually gaining acceptance, even among those who dissent from the inference which its use might seem to imply. The term "Aryan" properly belongs to the easternmost group of these languages, comprising the tongues of ancient Persia and northern India. But scholars like Penka, Poesche, Sayce, Taylor, and others, who contest the Asiatic origin of the Aryan race, are still willing to accept its Asiatic name.

When it was first discovered that most European nations spoke languages of the Aryan (or Indo-Persian) stock, the conclusion was at once drawn that these European Aryans must look for their ancestral home in the East. As no one doubted that all the nations of this stock had sprung from one source, it was natural to inquire in what place the primitive Aryan tribe had its original seat. It was natural also to adopt the view that this seat was to be found somewhere in that portion of central Asia to which the traditions embodied, however vaguely, in the earliest known compositions of Aryan origin, the Vedas and the Zend-Avesta, seemed to point. This region, which comprehends ancient Persia and Bactria, has, from the earliest times of which we have any knowl-

edge, been the home of Aryan communities. The reasons for accepting it as the peculiar seat of the race seemed conclusive to ethnologists until a very recent date. Of late years some scholars of high rank, both in Germany and in England, have been led to adopt the suggestion, first made by the late eminent English philologist, Dr. Latham, that the Aryans may have been of European origin. Their arguments were well summed up in the interesting address delivered last year before the Section of Anthropology in the British Association by the president of the section, Prof. Sayce. They have since been fully considered and discussed by Prof. Max Müller in his recent work, "Biographies of Words, and the Home of the Aryans." His decision is that to which the great majority of ethnologists have long since given their assent, namely, that the preponderant weight of argument points to an Asiatic home for the race. Some of the grounds for this conclusion will presently be shown; but, in the first instance, it becomes necessary to fix the locality of this primitive seat somewhat more definitely than it is placed in Prof. Max Müller's essay. He finds that the Aryan home must have been "somewhere in Asia," but declines to say more.

This conclusion, it is evident, is too indefinite for science; nor does it seem likely that the learned author, if he had cared to be more precise, would have had any difficulty in drawing a much narrower limit. The "method of elimination" is easily sufficient for this end. From the whole of Asia we strike out at once, by the common consent of ethnologists, its eastern third, comprising China, Japan, and Thibet, and along with it, by like consent, the three great southern peninsulas, the Indo-Chinese, the Indian, and the Arabian. With Arabia the rest of the ancient Semitic countries, Mesopotamia, Syria, and Phœnicia, will be erased from the problem. The immense expanse of Siberia will also disappear; for, though one bold speculator has sought a frigid home for the early Aryans in that region, he has, as might be supposed, gained no adherents to his theory. No one proposes Asia Minor; and Armenia and the Caucasus seem put out of the question by the fact that our earliest historical knowledge of those regions shows them inhabited mainly by non-Aryan tribes.

The limits of the pristine Aryan home are thus readily and inevitably narrowed down to those already suggested—the bounds of ancient Persia and Bactria—that "vast plateau of Iran," as Archdeacon Farrar has well styled it, in which the mother-tongue of the Sanskrit and Zend was once spoken by the united community, from whose divided septs the Vedas and the Zend-Avesta have been bequeathed to us. In that region, as we have every reason to believe, the Aryan race was found in its purest condition. When, therefore, we seek to ascertain the physical

and mental traits which properly belong to this remarkable race, we naturally turn our attention to that Medo-Persian people, in whom the character of the unmixed stock was first distinctly manifested. The results of such an inquiry may yield some valuable fruits to ethnological science.

But before proceeding with this branch of our study it will be necessary, if our search for the origin of the Aryan race is to be conducted on strictly scientific lines and to be carried back to the very germ of the race, to bear in mind the self-evident truth that every linguistic stock must have originated in a single household. Somewhere on earth there must have been an "Aryan family-pair," the progenitors of the breed; and all the speakers of the primitive Aryan tongue must once have been gathered, as has been well said, "under one roof." In an address which I had the honor of delivering before this section* two years ago, I endeavored to point out the conditions under which such a household must have been formed, and to show that it must necessarily have originated in some isolated spot where a little brood or a pair of orphan children, left alone at too early an age to have a completed language, could have found the means of subsistence. This must have been in some region where severe frost is unknown, and where food could readily be obtained by very young children all the year round. No such spot can be found in Europe, a fact which would make the rise of a new linguistic stock in that quarter of the globe, under its present climatic conditions, difficult to comprehend. But in the Aryan territory already described such a district presents itself at once in the semi-tropical belt which borders the Persian Gulf and the Indian Ocean, and is known in modern geography as the Deshtistan, or "low country," of the province of Fars—that province which has always been deemed the original seat of the Persian people. In this coast district, as we are told by Prof. Rawlinson, snow never falls and there is but little rain. Heavy dews, however, occur at night, so that the mornings are often fresh and cool. Most of the region is dry and barren; but along the streams there is moisture, and the fruits of the tropics thrive. The sandy shore abounds in shell-fish and especially in oysters. On the northern coast of the Mexican Gulf, where the climate and other conditions are somewhat similar to those of this Aryan belt, I have seen from my open window in midwinter, while the magnolias were blooming near and the orange-trees showed their belated fruit, the little children of five or six years old wading at low tide in the shallow water, feeling with their naked feet for the shell-fish and gathering them into their baskets

* The present article was read before the Section of Anthropology, in the American Association for the Advancement of Science, at its meeting in August, 1888. The "Vice-Presidential address" referred to is published in the Proceedings of the Association for 1886.

for breakfast. As wild fruits and edible roots also abound along this coast, affording abundant nutriment at all seasons, it is not surprising that several peculiar linguistic stocks among the American languages appear to have originated in that genial region—just as others are found under similar conditions along the coast of California. There is, therefore, nothing improbable in the supposition that the first Aryan family—the orphan children, perhaps, of Semitic or Accadian fugitives from Arabia or Mesopotamia—grew up and framed their new language on the southern seaboard of Persia. As the number of their descendants increased, they would naturally spread northward over the province of Fars, and thence into the wide regions bounded by the Tigris, the Indus, and the Oxus, which we have recognized as the primitive seat of the Aryan power.

In pursuing our inquiry into the distinctive characteristics of this race it will not be necessary to resort to many authorities. All the important evidence has been carefully brought together by Prof. Rawlinson in his well-known work, "The Seven Great Monarchies of the Ancient Eastern World." His lucid summaries are fortified by numerous references, and his conclusions are confirmed in the main by every writer who has treated on the subject. As regards the physical traits of the race, he presents us (in the third chapter of his history of the "Median Empire") with a picture which, according to our ideas, is highly prepossessing. "The general physical character of the ancient Aryan race," he observes, "is best gathered from the sculptures of the Achæmenian kings, which exhibit to us a very noble variety of the human species—a form tall, graceful, and stately; a physiognomy handsome and pleasing, often somewhat resembling the Greek; the forehead high and straight; the nose nearly in the same line, long and well formed, sometimes markedly aquiline; the upper lip short, commonly shaded by a mustache; the chin rounded and generally covered with a curly beard. The hair evidently grew in great plenty, and the race was proud of it." The color of the skin can not be determined from this source; but from other authorities and from the descriptions of ancient travelers we learn that it varied, and still varies, much as in central and southern Europe, from a fair and almost blond hue, with blue or gray eyes, in the northern highlands, to a clear brunette in central Persia, and an almost negro swarthiness along the torrid shores of the Persian Gulf. The Aryan complexion yields readily to climatic influences, and those who think they find the primitive type of the race solely in that small fraction of it which offers us fair skins, blue eyes, and flaxen hair, assuredly fail to observe in anthropology the rules of evidence which govern inquiries in every other branch of science.

Of the moral qualities of the race, the account given by the historian—whom no one will suspect of hostile prejudice—is not altogether so favorable. "Among their moral characteristics," he tells us, "the one most obvious is their bravery"—which (we are elsewhere told) was combined with a remarkable and persistent energy. "But this valor," he adds, "was of the merciless kind." Not only did their armies (in Scriptural phrase) "dash to pieces" the fighting men of the nations opposed to them, allowing apparently no quarter, but the women and children suffered indignities and cruelties at the hands of the savage warriors which the pen unwillingly records. "Spoil, it would seem, was disregarded in comparison with insult and vengeance; and the brutal soldiery cared little for silver or gold, provided they could indulge freely in that thirst for blood which man shares with the hyena and the tiger." This inclination to cruelty, as he shows more fully in his subsequent account of the Persians, was a marked characteristic of the race. Their ordinary punishments were of the most barbarous nature. They were not content with merely putting their criminals or enemies to death, but sought out ingeniously the methods of execution that would cause the most protracted torture. Crucifixion, impalement, flaying alive, and the terrible infliction of "the boat," described with revolting minuteness by Plutarch in his life of Artaxerxes, were common methods. Scourging and mutilation—the lopping of hands and feet, the tearing out of eyes—were the usual "secondary punishments."

This propensity to cruelty seems to be, in a certain way, connected with another governing trait of the Aryan character—a trait which, at first thought, might appear to be not merely alien but opposed to that propensity. This trait may be described as a constant and overwhelming sense of reverence. When we peruse the earliest known compositions of this race, the Vedas and the Avesta, and compare them with the Hebrew Scriptures and the poems of Homer and Hesiod, we observe one striking difference. With the Hebrews and Greeks religion was much, but their own people, their national history, their laws and institutions, their homes and their families, had a large place in their thoughts. With the early Aryans, of the unmixed race, their gods were all in all. Everything else, in comparison, was too insignificant to be dwelt upon for a moment. In this great mass of their primitive literature we find not a word relating to their history, except the merest hints, thrown out incidentally and, in a manner, unconsciously. With them man and his interests were as nothing. Why should not this worthless being, if he became offensive, be treated like a noxious insect or poisonous reptile—be crushed, impaled, flayed, or buried alive? Thus we may see how, with this

naturally bloodthirsty people, religion, which in other minds has led to the extreme of charity and self-sacrifice, might be combined with the worst exhibitions of cruelty.

This same overpowering sense of reverence, directed toward their earthly rulers, became an excessive servility, which made the Aryans incapable of freedom. On this important point the exact expressions of the historian deserve to be cited. "The feeling of the Persian toward his king," he tells us, "is one of which moderns can with difficulty form a conception. In Persia the monarch was so much the state that patriotism itself was, as it were, swallowed up in loyalty; and an absolute, unquestioning submission, not only to the deliberate will but to the merest caprice of the sovereign, was, by habit and education, so ingrained into the nature of the people that a contrary spirit scarcely ever manifested itself. In war the safety of the sovereign was the first thought and the principal care of all. . . . Uncomplaining acquiescence in all the decisions of the monarch—cheerful submission to his will, whatever it might chance to be—characterized the conduct of the Persians in time of peace. . . . The father, whose innocent son was shot before his eyes by the king in pure wantonness, instead of raising an indignant protest against the crime, felicitated him on the excellence of his archery. Unfortunates, bastinadoed by the royal order, declared themselves delighted because his majesty had condescended to recollect them. A tone of sycophancy and servility was thus engendered, which, sapping self-respect, tended fatally to lower and corrupt the entire character of the people."

He who is servile to his rulers is usually tyrannical toward his inferiors. We learn from the Greek historians what the government of the Persian monarch and his satraps was in their day, and modern travelers find that the lapse of twenty-five centuries has made no change in this respect, and little in any other. So far as history gives us information, no self-governing community has ever been found among any purely Aryan people.

One fine trait, however, which the ancient authors ascribe to the Persians should be recorded to their honor—their truthfulness. According to Herodotus, every young Persian was taught by his preceptors three main things—"to ride, to draw the bow, and to speak the truth. . . . In the Zend-Avesta, and more especially in its earliest and purest portions," continues Prof. Rawlinson, "truth is strenuously inculcated. Ahura-Mazda himself is 'true,' 'the father of all truth,' and his worshipers are bound to conform themselves to his image." This quality of truthfulness is not commonly deemed to be consistent with servility; but we must remember that the servility of the Aryans was the fruit, not of the timidity of conquered serfs, but of the reverence of

brave men for their earthly deities. The Turk, who bows implicitly to the vicegerent of Allah, is too proud to lie.

In intellectual capacity the people of the Iranic plateau held but a low rank, not only in comparison with their Semitic neighbors, but absolutely as a race. They had, indeed, or rather one profound thinker among them had, excogitated a religious system—the Zoroastrian—which is held to be of a cast considerably superior to the religions of the neighboring nations; but in all other respects their inferiority was marked. Of the Semitic Babylonians the historian observes that, "among the moral and mental characteristics of the people the first place is due to their intellectual ability. . . . Their wisdom and learning are celebrated by the Jewish prophets, Isaiah, Jeremiah, and Daniel. The Father of History records their valuable inventions; and Aristotle was not ashamed to be beholden to them for scientific data. They were good observers of astronomical phenomena, careful recorders of such observations, and mathematicians of no small repute." Of the Persians, on the other hand, he remarks that "we can not justly ascribe to them any high degree of intellectual excellence." The remains of their architecture and sculpture which have come down to us display, he considers, a comparatively inferior artistic ability; and "to science," he declares, "they had contributed absolutely nothing." It is deserving of note that not one of the great inventions and discoveries which have promoted the progress and welfare of the human race seems to have been of Aryan origin. For the alphabet, the smelting of metals, the making of glass, shipbuilding, the mariner's compass, the methods of agriculture and of textile manufactures, the laws of geometry and astronomy, the world has been indebted to other races. We might be inclined to ascribe the backwardness of the Aryans in these respects to the disadvantages of their situation; but we notice that they seem as a race incapable of appreciating and adopting the gains of other intellects. At the present day travelers find the Persians the least advanced of the Oriental races. They are behind even the Turks, and are far below the Chinese and the Japanese. They are now, as of old, a brave, handsome, and showy race, prepossessing and courtly, but are still shamefully servile, vilely cruel, scornful of science, and fatally unprogressive.

It is a common opinion that the excellence of the Aryan language affords evidence of high intellectual capacity in its framers. That there is some warrant for this view may be admitted; but it must be remembered that the opinion arose while the science of comparative philology was in its infancy. The wider linguistic knowledge of our times shows it to have been a greatly exaggerated estimate, the product to a large extent of mere ignorance and the conceit of race. Capacity for expression is the main test of

the excellence of a language; and, though the Aryan speech undoubtedly ranks well in this quality, there are found to be many languages in America and in Africa which decidedly surpass it. In certain other characteristics it is anything but admirable. Those who created and fashioned it seem to have been endowed with a peculiar linguistic talent or language-making faculty, which was not under the control of any logical force. What could be more absurd than the preposterous gender-system which the Sanskrit, the Greek, and the German have inherited from this Aryan mother-tongue, and from whose ridiculous trammels the speakers of all the later derived idioms in Asia and Europe have been for centuries striving to shake themselves free? The senseless superfluity of declensions and conjugations, the needless variety in the methods of forming the plural, the inordinate perplexity of the irregular verbs, are only a few of the evidences to be noted of the striking deficiency in logical and classifying power which, amid all their unquestioned excellences, the earlier Aryan languages everywhere betray.

But, it will naturally be asked, if the primitive Aryans were really a people of such moderate endowments, both in intellect and in morality, how do we explain the immense progress and the admitted headship and mastery among the nations of the world which their descendants have attained in Europe? The answer is ready at hand, and, indeed, almost self-evident. The people of Europe are of mixed race. They are Aryan exactly as the modern Peruvians are Spanish, or as the modern Egyptians are Arab. There is good reason to believe that primeval Europe was inhabited by tribes belonging to various races, differing considerably in character, but all of them distinguished by a love of freedom and a sentiment of personal independence. These traits caused the population to be broken up into numerous petty communities, each of which fell an easy prey to the Aryan invaders. The latter were not only, as we have seen, a race of remarkably brave and energetic warriors, but they had also the immense advantage, for an invading force, of a disposition which led them to render implicit obedience to their rulers. It is this trait of character which in Africa has often enabled the leader of a horde to establish his sway over a vast agglomeration of disconnected tribes. It is evident that in such a case, as in the case of the Turkish conquest of Asia Minor and eastern Europe, the subdued populations may be superior to their conquerors in every quality except in the capacity for combined effort.

The earlier inhabitants of Europe seem to have been of three distinct races—in the southeast Semitic, in the southwest Iberian, in the north and center Uralian. The Semitic tribes, which peopled Greece and probably a part of Italy and of the Mediterranean

islands, belonged apparently to that branch which is variously styled Hamitic, Proto-Semitic, Libyan, and North African. Issuing probably from Asia in the earliest ages, it peopled Egypt and Barbary, and made its way even to the Canary Islands. That it spread northward at various points across the Mediterranean there can hardly be a doubt. Its purest modern representatives are the Berbers, the hardy mountaineers of the Atlas range, of features and complexion almost European, and in character possessing precisely the traits which the Aryans lacked. This character can not be better shown than by copying the concise description given by Dr. Topinard in his "Anthropology." Of the Berber, regarded as the type of this race, he says: "A lively sentiment of equality, of charity, of his own dignity and of his personal liberty, a great desire for activity, love of labor, economy, attachment to his home, are his moral characteristics." All these traits appear in those most famous members of the Proto-Semitic stock, the ancient Egyptians, and with them a love of science and art and a strong inclination for literary production. Such, apparently, were the people in Greece and the adjacent islands and coast-lands of the Mediterranean, on whom the Aryans imposed their government and language and certain traits of their character How large an element of the Hellenic people this aboriginal population contributed is shown by the language. In that, as in all mixed tongues, the grammar is mainly from one source; it is almost purely Aryan. But the vocabulary shows a large infusion of words which can not possibly have come from any other source than from a subject race thus conquered and absorbed. Prof. Sayce, in the address already referred to, informs us that "Mr. Wharton has found, by a careful analysis of the Greek lexicon, that out of twenty-seven hundred and forty primary words only fifteen hundred can be referred with any probability to an Indo-European origin." To what linguistic stock this non-Aryan element in the Greek language belonged is a question which remains for philologists to determine; but every indication of locality and of physical type, of moral and mental traits, and of early Hellenic tradition embodied in the legends of Ægyptus, Danaus, and Cadmus, points to a Proto-Semitic origin. To this primitive race, whatever it may have been, were evidently due all the finer and nobler qualities of the Greek character and intellect. To their Aryan conquerors they owed, along with an increased comeliness and grace of shape and feature, their martial energy, their amenability to discipline, and doubtless certain barbarous usages, such as their custom of putting to death in cold blood their enemies taken in battle.

The Iberian race resembles the North African so closely in physical, mental, and moral traits that, but for the total difference

between the Berber and the Basque languages, ethnologists would be inclined to class them together. The Iberians, however, perhaps from their more northern and rugged abode, seem to have been a sturdier race, and more stubborn in maintaining their independence or reasserting it after a defeat. They occupied apparently the Spanish Peninsula, the greater part of France, the British Islands, Corsica, Sardinia, and probably a large portion of Italy, where they seem to have been mingled with the Semitic Pelasgians. The Aryan conquest, which in their case was incomplete, made little change in their character, except in Italy. In the far west the Celts have always shown the genuine Iberian character—the strong family affections, the love of home, the cheerfulness under all troubles, the sense of personal and tribal independence, and the jealous impatience of arbitrary power. To these traits the Aryans added in Italy a stronger infusion than was perhaps found anywhere else of their warlike and disciplined energy, and of their tendency to barbarity in war and to the infliction of cruel punishments in time of peace.

When the Aryan invaders entered the northern and central portions of Europe, they found that region occupied by tribes of the Uralian or Finnish type. On this point, and on the general question of the early peopling of Europe, I may cite the opinion pronounced, after many years of study, by one of the most eminent anthropologists of Europe, whose conclusions will be admitted by all to be entitled to the greatest weight—M. de Quatrefages. Referring in one of his recent works—"*Hommes Fossiles et Hommes Sauvages*"—to the "Finnish group," he observes: "This group has for European ethnogeny a very great importance. We know to what hypotheses, to what discussions, it has given rise. Both have been often premature, because the facts that were needed to establish the conclusions were not yet discovered. The 'Finnish theory,' to use the expression of Latham, is certainly wrong when it regards the whole of Europe as having been inhabited, before the arrival of the Aryans, by a single race, extending from Gibraltar to the Arctic Ocean—a race of whose existence the Finns would be merely the evidence. It is in the right when it admits the existence of a pre-Aryan population. This is a fact which can not now be questioned. We may affirm, moreover, that this population was not homogeneous; that it numbered several very distinct races; that these races have not been annihilated; that they have borne an important part in the formation of the existing populations, and that, in certain cases at least, they constituted in them the preponderant element." It is, of course, highly satisfactory to find that the conclusions to which linguists have been led by philological data are thus fully confirmed by the minute and careful studies of the physical types of European

races, ancient and modern, which have been pursued by this distinguished investigator for nearly half a century.

M. de Quatrefages proceeds to show the evidences of the former extension of the Finnish race through the countries now occupied by the Slavonic and Teutonic populations. Of one particular tribe his opinion will astonish those ethnologists who have held up this peculiar sept as the most primitive and typical remnant of the Aryan race. The Lithuanians, he finds, are in the main of Uralian origin. "Though they speak an Aryan idiom, they are nevertheless," he affirms, "not Aryan in blood. They are the brothers of the Esthonians, and if these are Finnish, as all the world agrees, the others are Finnish likewise."

Among the Finns he finds two distinct types. That which comprises the great majority of the people has a decidedly Mongol cast. The other inclines to the Aryan type. He has no doubt that among the so-called Finns and their congeners there has been a strong infusion of Aryan blood; and this admixture will sufficiently explain the traces of the Aryan language which many scholars, including Diefenbach, Weske, Cuno, and, lately, Canon Taylor, have pointed out in the Uralian dialects. The people of the proper Finnish type are of medium stature, sturdy and muscular, with large and square heads, long, broad, and square faces, the lower jaw strongly developed, the nose small and rather wide, the mouth large, the complexion fair, deepening to olive gray; the eyes small, sometimes slightly oblique, the iris a grayish blue or bluish gray; the hair flaxen in hue, or sometimes of a reddish yellow, straight and silky. In character they are serious, manly, thoughtful, taciturn, slow in movement, both physically and mentally; very conservative, disposed to live at peace with the authorities; somewhat suspicious and vindictive; patient and resolute under suffering; not demonstrative, but kind and helpful to their neighbors; and at bottom thoroughly honest and faithful.

In all these traits, both physical and moral, we see clearly the basis of the Slavonic type and, to a large extent, of the Teutonic; though here apparently there has been some admixture of another primitive element, probably the Iberian. Over all is impressed, and more especially, as might be expected, among the higher classes, the influence of the Aryan conquerors, who, to use the striking expression applied by the poet Campbell to the Normans in England, have "high-mettled the blood" of the race. Under this influence the Uralo-Aryan nations of northern and central Europe, while still patient, conservative, and long-enduring, have become capable of united action, of strenuous effort, and of a resulting progress in thought and freedom which the Aryans themselves, in their primitive seats, have never been able to compass.

Nothing is more certain than that the immense advance of the European Aryans (so styled) beyond those of Asia has been due mainly to the aboriginal races whom the Asiatic invaders overcame by virtue of their superior organization, but whose posterity still constitutes the main element in the population of Europe. The simple comparison of the Iranians, ancient and modern, with the nations of the West, affords ample evidence on this point. Of the ancient Persians we have had a vivid portraiture from Rawlinson. Their modern descendants are described to us by a late traveler, Mr. Arthur Arnold, an English gentleman of keen discernment and of much experience among Oriental races. In his recent work, "Through Persia by Caravan," he gives an account of the government and the people, which shows them both to be much as they were in the days of Xerxes. Of all governments above the grade of savagery, the Persian seems to be the worst; and all that can be said for it is that it faithfully reflects the character of its people. The ordinary punishments are still, as in former days, death and the bastinado; and each of these punishments is inflicted with the most ingenious refinement of cruelty. Shortly before Mr. Arnold's arrival, the governor of Fars had endeavored to repress crime in that province by a special exhibition of energy. "He tried," we are told, "throat-cutting, and left the bleeding bodies exposed to the view of all comers in the public square of Shiraz. He tried crucifixion, nailing the wretches by the hands and feet to the walls of the town, and leaving them under a guard of soldiers to die of exhaustion and starvation. Finally, he tried burial alive in pits, or cylinders of brick-work, of depth such as to allow the criminal's head to appear above the top;" in which condition, we are told, "the miserable men were in their dying hours barbarously ill-treated, on their exposed and defenseless heads, by the rabble and soldiery of Shiraz."

Such is the race whose ancestors achieved the conquest of Europe some two or three thousand years before the Christian era, subduing gradually the scattered and disorganized tribes of Semitic, Iberian, and Uralian origin. As has been already noted, the two traits of Aryan character which, in addition to the personal valor shared by them with their opponents, especially insured the success of the invaders, were their worship of hereditary rank—a base sentiment, almost unknown to the other great races of mankind—and their ruthless cruelty to the conquered. The former trait gave them union and discipline, the other made them terribly formidable. Both traits have survived to our own day in the dominant class throughout Europe. In the feudal system, the state of society to which these qualities gave rise attained its highest development. A carnival of tyranny, superstition, and cruelty prevailed for several centuries throughout the finest por-

tion of Europe. At length a change occurred. The subject races grew in strength. Various causes conduced to this result—the invention of gunpowder and of printing, the discovery of America, the advance of science, and, finally, the operation of that natural law by which oppressed populations, unless kept down by massacre, tend to increase faster than their oppressors. At last the struggle came to a head in France, just a hundred years ago, when, with the destruction of the Bastile, the Iberian race in that country regained the control of its own destinies, and the ascendency of hereditary rank, with its resulting system of arbitrary, corrupt, and cruel government, was swept away. In the British Islands, where the oppression was less severely felt, the reconquest has advanced, during the past two or three centuries, by more gradual steps—from the Great Rebellion to the Reform Bill of 1832, when the Uralian Saxons regained a substantial equality—and thence to the later movement of the present day, when the still earlier Iberian stratum of population is rising to the light and to its due share in the government.

It is not, of course, to be inferred that the members of any European aristocracy are all necessarily, or even probably, of Aryan descent. There has, undoubtedly, been a large and often repeated intrusion of members of other races into their ranks. In ancient India, where the three higher castes, the Brahmans, Kshatriyas, and Vaisyas, claimed, and doubtless rightly, to be of Aryan origin, it is certain that many Sudras, from the aboriginal races, have found, from time to time, admission among them. But the descendants of these intruders speedily became absorbed in the caste which they had entered, and assumed all its characteristics. When the hereditary or patrician principle was once introduced into Europe by the Aryans—the principle that the son of a noble was superior in political rights to the son of a commoner—a genuine caste was at once established; and this caste, while its membership has been partially changed, has, by the force of position and of interfusion of blood, remained the same in character to our day. Many a Norman baron was of plebeian origin, but the Norman baronage was none the less an Aryan caste. The father of Front-de-Bœuf may have been an Iberian peasant, but his children and grandchildren became the members of a privileged aristocracy, closely allied by blood and intermarriage with all the other European aristocracies, and sharing with them the traits of character which they had inherited from the Aryan conquerors.

If any are disposed, even in the face of the striking evidence of India and its caste-system, to question whether the results of a conquest made in Europe probably not less than four thousand years ago can be so clearly evident at the present day, they may be reminded of two facts which, in different ways, will serve to

confirm what has been said on this point. The conquest of France, Spain, England, and other portions of Europe, by the Romans took place about two thousand years ago. The evidences and results of this conquest, in the languages, institutions, features, and character of the conquered nations, are everywhere apparent at the present day. No one dreams of doubting them, and this simply because we have written and monumental evidence of the facts. Why should we doubt that the results of a conquest made two thousand years earlier may survive in equal vigor, though in the nature of things no written or monumental record of it can have come down to our time? The memorials of it which remain are of a different, but, to an ethnologist, not less convincing character. One of these may be noted in the other fact to which reference has been made. A very high authority in comparative philology, Dr. Friedrich Müller, in his great work on Linguistic Science (*Grundriss der Sprachwissenschaft*), after remarking that the numerical system of the Indo-Germanic languages rests on the decimal system, adds that the Celtic alone shows traces of the vigesimal system, which are to be referred to the influence of the Basque language. The Iberian Basques reckon by digits to twenty, which is, in their language, a distinct word, *hogei* (or *oguei*); forty is *berrogei*, "two hogeis"; eighty is "four hogeis"; and ninety-seven would be "four hogeis and ten-seven." The Celtic has a double system. Twenty is *fiche*, a corruption of the Aryan term; for forty the Celt can say either *cethor cha*, an Aryan contraction of "four-tens," or *dá fichit*, "two twenties." Ninety-seven is either "nine tens and seven," or, as in the Basque, "four twenties and ten-seven." Now, the French language, as is well known, adopts both methods, in different parts of its ascending scale. As far as sixty it proceeds by the decimal system; then it abruptly changes to the vigesimal. The Frenchman, when for ninety-seven he says "four-twenties-ten-seven" (*quatre-vingt-dix-sept*), has no idea—unless he is a philologist—that he is translating an ancient Iberian idiom into a corrupt form of Aryan speech. If we consider what this fact really signifies, we shall see that the whole ethnological history of France is embodied in it. This French system of enumeration, now in actual use, tells us that the people who employ it are mainly of Iberian origin; that an Aryan language in its most corrupt and disintegrated form, the Celtic, was once imposed upon them; that this has again given place to the Latin form, which has been further mangled and debased by the influence of a still later Teutonic conquest; and that through the whole of these overlying strata, caste imposed upon caste, the vigorous Iberian element has forced its way to the light, and governs to this day, in this composite population, that most striking manifestation

of the intellectual development of a race—its higher numeral system.

It would be easy to add many other illustrations from history, from physical traits, and from linguistic data, but they will hardly be deemed necessary. The conclusion to which we are brought by all the evidence is, that while the conquering energy of the European nations is doubtless due to the infusion of Aryan blood, their higher intellectual qualities and their love of freedom are derived almost entirely from the earlier races, who form the main elements in the mixed European breed. The gradual elimination of the Aryan blood and character, with the return of these earlier elements to ascendency, is the most impressive and important phenomenon in the modern history of Europe, and indeed of the civilized world. We see its results in the extension of free institutions, in the growth of science, in the multiplicity of inventions, in the lessened barbarity of war, in the abolition of slavery, in the increased sense of brotherhood among nations, in the diffusion of education, in the countless societies for charity and for learning, and in all the other evidences of material and moral progress which distinguish our age.

THE AMERICANISTS IN CONGRESS.

THE Seventh International Congress of Americanists met in Berlin, on October 2d, and was opened by Honorary President Gossler, the Prussian Minister of Worship. Although Germany, the speaker said, "had not had any remarkable part in the discovery of America, or in the earliest steps in planting European civilization in the new quarter, it had participated in a rising degree in the scientific discovery of the continent. Americanist studies had, through the brothers Humboldt, already gained burger-rights among us, and had consequently received faithful care; so that the congress finds among us a well-prepared audience, fully appreciating its aims. We understand that a quarter which includes within itself all the zones, all earth-forms, all degrees of civilization, must be closely examined as to its inner relations before the important question whether the peculiar features of the New World indicate any primary connection with the Old can be answered. We recognize, also, that in some districts of America history and prehistory lie far apart; that powerfully organized states, with elaborate constitutions and carefully regulated religious rituals, were destroyed centuries ago, while in the same neighborhoods numerous tribes are still living apparently in a state of nature. The words that were spoken at the

first congress in Nancy—"not systems but facts"—have become the programme of the Americanists; doubly valuable in a time when the imagination is too ready to fly heedlessly over wide tracts which disclose their features only to toilsome searchers. Previous congresses have made numerous and important contributions to the structure which we are raising. From meteorology, geography, and the descriptive sciences, to comparative philology and the history of art and religion, the various branches of knowledge have offered their treasures. The circle of studies that help to the investigation of the New World is ever widening, and our extended knowledge of East Asian history and literature is opening to us new means of access to the last of these problems."

Minister Gossler was followed by Signor Guido Cora, who spoke of the discovery in the Vatican archives of important original documents of the time of Columbus.

Dr. Reiss, of Berlin, was chosen president of the congress, and the vice-presidents were Freiherr von Audrian-Werburg, of Vienna; Cora, of Italy; Fabié, of Spain; Gafarel, of France; Morse, of the United States; Netto, of Brazil; and Schmidt, of Copenhagen. At the close of this introductory meeting the president spoke of the condition of Americanistic research and the part which different countries had taken in it.

The first of the regular papers was by Signor Cora, and was on the name of America. The author was not ready to pronounce decisively upon the origin of the name, for various recent investigations had left it uncertain whether it was derived from some word of native origin or was imported. Señor Fabié remarked that the opinion should not be rejected that the name was derived from Amerigo Vespucci, for it had been taken from the maps of that traveler, which were signed with his name.* M. Gafarel spoke concerning the American navigation which was carried on principally by Frenchmen, early in the sixteenth century. The whale-fishery had brought Basques, Bretons, and Normans through the northern seas to Canada, as was shown by many names of points along the coast. In the discussion, M. de la Espada tried to prove that M. Gafarel had exaggerated the part which those discoverers, particularly the Basques, had played. The whale-fishery was not then very extensively prosecuted; but

* M. Jules Marcou says, in the "Bulletin of the Paris Geographical Society," that "it is beyond question that one edition of Vespucci's letter on his third voyage has the name Amerigo in the place of the Christian name; nineteen editions had Albericus, and subsequent Italian editions had Alberico. The one with Amerigo on the title-page was published in 1506, but M. Marcou suggests that this was never intended to be a variation of Alberico, but rather the adaptation of Amerrique, a name already known and applied to the New World, to Vespucci's name to distinguish him, as we say now 'Chinese Gordon,' to distinguish the particular Gordon by suggesting one of his greatest feats."

the presence of the names referred to could be explained by assuming that a few Basques had occasionally reached Canada in Spanish ships. Señor Fabié announced that the Spanish Government was contemplating the full publication, on the approaching four-hundredth anniversary of the discovery of America, of the manuscripts in its archives by and concerning Columbus.

The antiquities of Mexico and South America were the foremost subjects for discussion at the second session. The relics called *agripearls* were the occasion of a long debate. They were formerly regarded as peculiar to the Old World, particularly to Africa, but they had recently been found in all parts of America. According to Tischler's researches, the technic of the colored glass pearls corresponded exactly with that of the Venetian Millefiori glasses, and was so essentially different from that of the ancient Roman glasses that they must be ascribed to the beginning of the Renaissance. M. de la Espada agreed as to the European origin of the pearls, and that they had been used in America as ornaments for horses but not for men. Some ancient Mexican mosaic decorations upon human bones were described by M. Andrée as showing a high development of technic and taste. Only eighteen pieces of this kind are known, which have been placed in European collections. Some of them are masks worked out of real skulls or of wood, and others are figures of animals, etc. The mosaic is composed of small pieces of turquoise, malachite, or mussel-shell, pressed into a foundation of pitch, and forming a carefully elaborated design, or representing in colored shadings the forms of the human face. The Berlin Museum possesses a skull-mask of this kind, a head of a puma, and a figure composed of the fore-parts of two animals.

Prof. Morse presented a paper by Mr. Cushing, on the object and methods of the Hemenway Archæological Expedition into southwestern Central America. The exhibition arranged by the Berlin Museum contains the results of the excavations made by Mrs. Hemenway on the Rio Salado in Arizona. It has been shown that the desert which now exists in that territory was formerly a richly populated and cultivated region. The remains of seven cities and of extensive canals for conducting the waters of the Salado and another river over the land have been discovered. The condition of the ruins indicates that this ancient, pre-Columbian civilization was destroyed by an earthquake, after which the inhabitants probably emigrated to Mexico.

Senhor Netto, of Brazil, had examined a series of mounds of elliptical ground-plan, with a head-shaped annex, in which were found relics of a people who might be distinguished from the present Indians chiefly by the prominence of female influence among them. All the vases and urns, some of which were quite

shapely, were marked by ornaments and designs that were exclusively feminine. Numerous thin sheets of earthenware, shaped like a spherical triangle, and often carefully ornamented, perforated at the corners, appear, from the figures on the vases, to have been worn as "fig-leaf" dresses by the women. The very general tattooing of the women's bodies also points to their having held a high position. Later strata furnished remains of another race, among which this exalted position of the women was not apparent.

Prof. Virchow discussed the present condition of knowledge respecting nephrite and jadeite. Désor had assumed, at the Archæological Congress in Brussels, that all the nephrite was derived from two stations in central Asia, and all the jadeite from Burmah. In the mean time, two natural occurrences of nephrite in serpentine had been observed at Zabt, in Silesia, and one in Switzerland, besides a locality of jadeite. Further, a block of nephrite had been found in the Bodensee, which bore plain marks of pieces having been taken from it. Thus, these stones had been found, and evidently worked, in Europe. M. Arzruni had discovered that both species were subject to considerable variations, and that, therefore, every severed specimen found should be tested for determining its origin with respect to the special properties of its material. The specimens sometimes exhibit remarkable relations. Thus, the famous Humboldt axe and another South American hatchet seem to be identical in substance with the European mineral, and a hatchet from Venezuela with one from Hissarlik.

In his remarks upon the anthropological classification of the native Americans, Prof. Virchow admitted that it would not do to speak of a primitive race; yet the ancient skulls are predominantly of a brachycephalic type. These forms seem to have persisted in the South to the present time, but in the North there had been a noticeable transition to long and medium forms. Herr Fritsch suggested an archæological division on the basis of his studies of the hair. He distinguished two groups of people, one with smooth or waving, moderately long, brown hair, like that of the Polynesians, and the other with coarse, stiff hair, inclining to deep black, like that of the Mongols. The former group includes the Central Americans, and, generally, the ancient civilized peoples of South America, and the other the northwestern tribes, with those of single districts in the South. Even if the supposition of a Mongolian immigration in prehistoric times is admissible with respect to this latter group, it can not be held, so far as present researches show, with regard to the ancient civilized peoples.

Herr Nehring, speaking of the domesticated animals of the

ancient Peruvians, observed that the subject was scientifically important, because all the other peoples of ancient America were very poor in this kind of property as compared with the Peruvians and Bolivians and some of the Central American peoples; and, secondly, because the influence of domestication on the formation of races could be better followed on these animals than on those of the Old World. We are concerned in Peru especially with the dog, llama, alpaca, and guinea-pig. The speaker had examined eighteen dog-mummies from ancient Peruvian graves, and had determined that they belonged to three different races—a shepherd's dog, a *Dachshund*, and a bull-dog or pug. He believed that the "Inca-dog" was derived, not from other South American *Canidæ*, but from the Mexican wolf (*Lupus occidentalis*), perhaps through the feebler Texan variety; and that several races had been formed from it in Peru through domestication. In this Herr Nehring dissents from and contradicts Von Tschudi's opinion that the varieties had arisen from crossing with European dogs. As the dog and likewise the llama and alpaca are undoubtedly of America, so also, in the speaker's opinion, is the guinea-pig, notwithstanding B. Hensel and other authors believe that it was introduced from Europe. The fact that no remains of guinea-pigs of prehistoric age had ever been found in Europe told against the latter view. A short discussion ensued upon the cropping or amputation of the ears of ancient American dogs, of which Seler had observed evidences in Mexican pictures, and Nehring had found that it had been practiced on Inca-dogs.

Herr Wittmack presented a paper upon the useful plants of the Peruvians, which was based chiefly upon traces found in their graves. Their bread-plant was maize, which their sculptured works and the ornamentation of the pillars of their temples and palaces show was held in high esteem among them. Three varieties of this plant have been distinguished—Indian corn, the pointed-grained, and the umbilicated. Besides maize, a kind of lamb's quarters (the seeds of *Chenopodium quinoa*) and two kinds of pulse were utilized, and the speaker inferred that our bean was derived from America. Small tubers like potatoes, but which could not be determined, and fruits of the anotto, had been observed in the graves.

Concerning the inhabitants of Mexico at the time of the conquest, Herr Hartmann remarked that the reports of the *conquistadores* left us in the dark, and we were therefore sent to the ancient representations. His own researches indicated that Montezuma's people had the same physical race characteristics as are exhibited by the present Dakotas, Pawnees, Comanches, etc. The Araucanians, Patagonians, and Fuegians might likewise be re-

garded as related to the Aztecs; in fact, he had often found among them the peculiar, dreamy, melancholy facial expression which is ascribed to the ancient Mexicans. In the light of the later researches, Colombia, the country of the Chibchas, the third most important people in pre-Columbian America, obtains a special significance, because it was the region which at the time of the discovery prevented contact between Mexican and Peruvian civilizations. The speaker produced linguistic evidence that the Chibchas, who were resident in the heart of Colombia, were not an immemorially isolated people in the sense in which they had formed one of the puzzles of the New World. They had near relatives in the people of Costa Rica and northern Colombia. People of Chibcha and Mexican origin met in Costa Rica. According to these evidences the dispersion of the Chibcha people may be historically conceived by assuming that originally dwelling near Cundinamarca, they afterward spread out, and were still later scattered by the influx of wild Brazilian tribes and driven to the mountains, where they lost their connections. A paper was also presented by Herr Uhle on the primitive history and wanderings of the Chibchas.

Other papers were read by Messrs. Borsari, on the constructions of the ancient Peruvians; Müller, on the Sambakis of Brazil, a people who had a prehistoric civilization; Von den Steinen, on his second journey to the Xingu, in which certain conclusions, particularly those respecting the relationship of the Tupi and the Caribs, which he had formed in his former journey, were confirmed; and on the Calendar-stone and various antiquities, statuettes, and potteries of Mexico and Central America. M. Hamy made some remarks at the close of the meeting on the falsification of American antiquities, which had reached a great height, and exhibited an album containing specimens of the counterfeits. —*Translated for the Popular Science Monthly from Humboldt.*

THE importance of educating youth for the duties of citizenship is made more obvious at every general election. As indicated by Prof. Woodward, of St. Louis, some months ago, a course of civics in the public schools should embrace an analysis of our scheme of government, national, State, and municipal, with a general statement of the functions of each; the necessary expenses of each of the governments, with a detail of the institutions that must be supported by taxation; the methods in use of levying and collecting taxes; and the duties of citizenship—such as the maintenance of individual independence; the contribution of one's share in taxes to the necessary expenses of government; participation in all measures necessary to secure the selection of faithful and competent servants to discharge the duties of government; the cultivation of a proper public opinion in favor of honesty, temperance, and the refinements of civilized life; and the contribution of something, small or great, to the common weal, beyond the duties specially named, whereby the world may be the better for one's having lived in it.

SKETCH OF PIERRE BELON.

"IN 1555," says M. Louis Crié, "Pierre Belon, of Mans, well known by his travels in Italy, Greece, and the East, revealed himself as an observer of great sagacity and as a bold thinker. With him came at once the end of compilation and the beginning of observation. He added to the common treasure of knowledge more wealth than all his predecessors from antiquity and all his contemporaries put together." M. Gustave Tissandier calls him one of the great *savants* of the sixteenth century, who, like his contemporary, Bernard Palissy, would rather study facts in the book of nature than in men's books– "a conscientious observer, fascinated with the truth, we may consider him one of the initiators of modern natural history."

PIERRE BELON was born at Soulletière, near Mans, in 1517, and died in 1564. His tastes for studies in natural history were developed at an early age, and were encouraged by his friend René de Bellay, Bishop of Mans, with whose aid he entered upon the study of medicine at Paris. There he formed a friendship with the poet Ronsard. Having obtained his doctor's degree, he went, in 1540, to Würtemberg, to attend the lectures of the botanist Valerius Cordus. In company with his teacher he traveled through Germany and Bohemia. The country was greatly excited over the controversies of the Reformation; and at Thionville, on his return journey home, he was arrested by the Spanish occupants, under suspicion of being a partisan of the new doctrines. He was obliged to buy his freedom with funds that were advanced by a learned gentleman named Dehamme, who was a great admirer of Ronsard. Returning to Paris, he found generous protectors in Bishop Duprat of Clermont, the Cardinal of Lorraine, and the Cardinal of Tournon. Tournon provided him with quarters in the Abbey of Saint-Germaine, and advanced the cost of the voyages which he desired to make for prosecuting his studies. The words in which Belon conveyed his request for this aid at once attest his earnestness in the pursuit of his object, and illustrate the spirit of a time when the small were free to call upon the great for help in such matters. "When you know," he said, "the desire that I have to obtain knowledge of the things pertaining to the material of medicines and plants, which I can not well acquire except by a long pilgrimage, you will be pleased to command me to go and seek them in distant regions, in the places of their origin."

Belon left France at the beginning of 1546, and was gone between three and four years. He went to Crete and Constan-

tinople; then visited Lemnos, Mount Athos, Thrace, and the Grecian islands; thence went to Egypt, where he made observations that have become famous at Alexandria and Cairo; traveled through Palestine, Syria, and Asia Minor, to Constantinople; and returned to France, by way of Rome, during the year 1549. To his friend Ronsard this journey had all the adventure and importance of a general exploration of the globe, and he celebrated it appropriately in verse, glorifying Belon as if he had been one of the greatest of navigators.

The accounts of his observations during this great tour were published in the remarkable book known as "The Singularities," the full title of which is, "Les observations de plusieurs singularités et choses mémorables trouvées en Grèce, Asie, Judée, Egypte, Arabie, etc., et autres pays estranges" ("Observations of many Singularities and Memorable Things found in Greece, Asia, Judea, Egypt, Arabia, and other Foreign Countries"), Paris, 1553. It was illustrated with numerous figures of animals and birds, etc., engraved on wood. This book abounds in novel observations on the natural history and geography of the countries visited, with descriptions of their monuments or ruins, and of the manners and customs of their people. One of the most interesting parts of it, according to M. Louis Crié,* is the story of his travels in Egypt, in which "we read with pleasure the pages which he has devoted to the geography, ethnography, medicine, the fauna and flora of that strange country. Very curious details are found in his book respecting Alexandria, the manners of the Alexandrians, the city of Rosetta, the fishes of the Nile, the houses and gardens of Cairo, the pyramids, "the mummy," the plants that grow around Suez, etc. The same work contains a plan of the city of Alexandria and views of the island of Lemnos, Mount Athos, and Mount Sinai. Although the geometry of these cuts is elementary, they give evidence of careful observation. Belon drew after nature, and for the first time, such animals as the ichneumon, the hippopotamus, the crocodile, the chameleon, the hawk, the black ibis, and several fishes. His 'Singularities,' replete with local originalities, is remarkable for the amplitude of the information it affords. We notice in it rigorous good faith attentive to the discovery of the significance of facts without dissimulating in anything." A queer description is given of the giraffe, "whose fore-feet, when it runs, go together. It lies with its belly against the ground, and has callosities on the chest and thighs like the camel. It can not feed on the ground standing without spreading its fore-legs away out, and that is very hard. Hence it is easy to believe that it does not live in the fields, but upon the branches of trees, having a neck so long that it can extend its head to the

* "Les Voyages de Pierre Belon." "Revue scientifique," 1883, No. 7.

height of a short pike. And having drawn it from nature, we here present its portrait."

In 1556, King Henri II granted Belon, in recognition of his work, a pension, which appears to have never been anything but honorary. He was also given a residence in the Château de Madrid, in the Bois de Boulogne, where, during the remaining years of his life, he studied natural science and wrote his celebrated books. One evening in 1564, as he was crossing the Bois, on the way to visit his friend Jacques du Breuil, he was attacked, by highwaymen, it is supposed, and killed, in the forty-eighth year of his age.

FIG. 1.—PORTRAIT OF THE GIRAFFE (after Pierre Belon).

The "Natural History of Fishes"* marks Belon, according to M. Crié, as the founder of modern ichthyology. "While rectifying and enlarging what Aristotle had said, the Mansian naturalist gave a positive basis to icthyology by descriptions and figures of a considerable number of species. In the 'Aquatilibus' are described a hundred and ten fishes, of which twenty-two are cartilaginous, seventeen fresh-water, and the rest sea fishes. . . . The figures representing them are easily recognizable, notwithstanding the simplicity of the style of the wood-engravings.

"His philosophical mind had a very correct appreciation of the genera. His groupings were made with a surprisingly just instinct. To an indefatigable activity he joined vast erudition. He brought to the front the study of nature and of the books that treat of it. . . . The feature that especially prepared new bases for the science of fishes was his observations on the thoracic and abdominal splanchnology of those animals. He gives with infinite sagacity correct details respecting the liver, its shape, and the number of its lobes; the spleen, its position, vol-

* "Histoire naturelle des estranges poissons marins, avec le vraie peinture et description du dauphin et de plusieurs autres de son espèce," 1551, with woodcuts; "Nature et diversité des poissons, avec leurs portraicts," 1553; "De aquatilibus libri duo, cum iconibus ad vivam ipsorum effigiem quoad fieri potuit," 1553.

ume, and size; the gall; the intestine, its direction and disposition; and the pyloric appendages, which he called *apophyses cæcos*. Long before the fine researches of Cuvier, Mierendorff, Valenciennes, and Duvernay, Belon first studied the conformation of the liver in more than thirty species of fishes." We copy from this book a curious picture of a hippopotamus of the Nile devouring a crocodile (Fig. 2). The germ of embryology appears

Fig. 2.—The Hippopotamus of the Nile (after Pierre Belon).

in a most remarkable manner in a representation, in the first of the books named in our note, of the matrix and embryo of the porpoise. These works, in which the genius of Belon showed itself to be of a superior order, were followed by the book on the "Nature of Birds," * which is described by M. Crié as an "imperishable work, a fruitful source of instruction to the philosopher and the naturalist." It was the crowning work of Belon's life, and marks an era in the history of science, for in it was developed and illustrated the idea of a uniform plan of structure among animals. Belon had already in his "Fishes" and his descriptions of plants definitely applied the distinctions of genera and species, and had invented the binary nomenclature to take the place of the long-drawn and often not satisfactory descriptions with which previous authors had tried to mark these differences. More than one hundred and eighty years before Linnæus he had brought similar plants into single groups, to which he applied common or generic names—as *Fagi, Ulmi, Fraxini, Aceres, Corni*, etc.—and had then substituted for the usual descriptive phrase a specific name, sometimes an adjective relating to an external quality, as *Smilax aspera, Smilax lævis, Papaver corniculatum;* sometimes one of the common names of the period or of a celebrated person.

At the very beginning of his book on "Birds," Belon placed a representation of the skeleton of a bird face to face with a human skeleton, and marked by a common lettering the features and parts common to both. By this, creating the comparative method,

* "Histoire de la nature des oyseaux, avec leurs descriptions et naifs pourtraicts retirez du naturel, escripte en sept livres," 1555.

he opened a new pathway in science. The thought of unity thus presented for the first time by Belon is the same that was declared two hundred and fifty years afterward by Geoffroy Saint-Hilaire. Belon's division of birds—into the *Fissipedes* and the

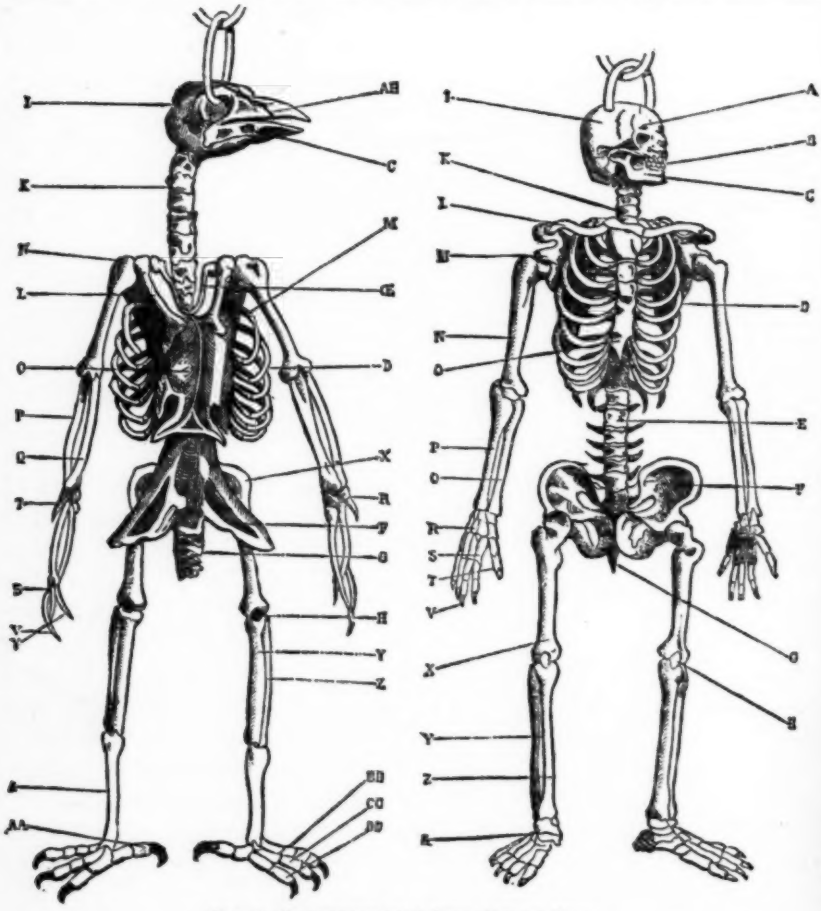

FIG. 3.—SKELETONS OF A BIRD AND OF MAN.

AB. Birds have no teeth, but a cutting beak, strong or weak, large or small, according to the matter they have to pick to pieces and on which they live. M. Two long and narrow scapulæ, one on each side. Œ. Bone called the merry-thought, or breast-bone, found in no animal except the bird. D. Six ribs, attached to the chest of the stomach in front, and behind to the six vertebræ of the back. F. The two bones of the hips are long, for there are no vertebræ below the ribs. G. Six bones of the rump. H. The round bone of the knee. I. The sutures of the skull do not show unless it is boiled. K. Twelve vertebræ of the neck, and six of the back. L. The two key-bones. N. The bones of the arms or shoulders. O. The chest of the breast. P. The little bone of the elbow. Q. The large bone of the elbow. R. The bone of the wrist, called carpus. S. The knots and articulations, called condili. T. The pinion, called appendix, which is related to the wing as the thumb to the hand. T. The bone after the wrist called metacarpium. U. The extremity of the wing, which is like our fingers. V. A number of bones at the end of the wing, two of which have the form of netting-needles (or shuttles); one larger and the other smaller, which is proportioned in the bird as in us the hollow of the hand, which is called in Greek *Thenar*, and in Latin *Palma*. X. The large bone of the thighs, one on each side. Y. The large bone of the leg. Z. The small bone of the leg. &. The bone given for the leg to birds, corresponding with our heel. AA. Just as we have four (*quatre*) toes on the feet, so have birds four (*quatre*) fingers, the hinder one of which is given in proportion as the big toe with us. BB. Four articulations in the outer finger. CC. Three articulations in this finger. DD. Two articulations in this finger, as also in the hinder one.

Palmipedes—is precisely that of Cuvier which is taught in elementary books. Other correspondences of classification with the classifications of Linnæus and Cuvier will be found in the following table:

Belon's classification.	Classification of Linnæus.	Cuvier's classification.
Day and night birds of prey.	Accipitres.	Birds of prey.
Birds having flat feet and swimming on the water.	Anseres.	Palmipedes.
Birds having flat feet, etc.	Scolopeces, or Grallæ.	Waders.
Birds that build their nests on the ground.	Gallinæ.	Gallinaceæ.
Birds that are found everywhere.	Gallinæ Passeres.	Gallinaceæ Passeres.
Birds that haunt hedges, sticks, thickets, thorns, and briers.	Passeres.	Passeres.

The main classification of birds has thus not been materially changed since 1555. The portrait of a wren is a specimen of the ordinary illustrations in "The Birds" (Fig. 4).

Belon composed a treatise on agriculture,* in which was included a list of exotic plants which it would be desirable to acclimate in France, and suggested the foundation of an establishment for that purpose. Something of the kind was carried out under Belon's direction by René de Bellay on his estate of Touvoy, near Mans.

Fig. 4.—The Wren (after Pierre Belon).

Besides the works already described, Belon published a history of conifers † and a treatise on the funeral monuments and sepulturral usages of the ancients and the substances used by them for the preservation of bodies.‡ According to Renouard, he translated the treatise of Dioscorides into French. He also made a version of Theophrastus's "History of Plants," which has been lost. The magnitude of his works indicates that he had an enormous capacity for labor. His writings on anatomy, botany, agriculture, and medicine, as measured by M. Crié, display a rare critical faculty, and nearly all his observations overreach the horizon of his epoch.

A statue of the great naturalist was unveiled at Mans on the 9th of October, 1887, with an address by M. Crié. The portrait we publish is a copy of the engraving that was prefixed to the "Singularities," and represents Belon in his doctor's cap.

* "Les remonstrances sur le défaut du labour et culture des plantes, et de la connoissance d'icelles, contenant la manière d'affranchir et apprivisoir les arbres sauvages," 1558.

† "De arboribus coniferis, resiniferis, aliisque nonnullis sempiterni fronde virentibus," 1553.

‡ "De admirabili operum antiquorum præstantia," 1553.

CORRESPONDENCE.

THE GREAT SOUTHERN TORTOISE AGAIN.

Editor Popular Science Monthly:

MY object in writing to you on November 1, 1888, was, as I then stated, to call the attention of Prof. Shaler to the error into which he had fallen in attributing to the *gopher* (a tortoise) the habits of the *salamander* (*Geomys pinetis*), a small rodent. I did not expect my remarks to be published by you, but I did expect Prof. Shaler, as of his own motion, to make through your pages some explanation or acknowledgment of his blunder; and had you been content to simply print my note in your January number, I should not now feel called upon to make further reference to the subject. The only inference to be drawn from your editorial comments upon my note is that you have not read Prof. Shaler's article on the "Habits of the Great Southern Tortoise," which appears in your journal for November, 1888, and to which my note refers!

The question is not, as you appear to suppose, which animal, the *gopher* or the *salamander*, produces the greater effect upon the soil of Florida. What I wish to point out is the fact that a reputed scientist has published in a scientific journal an article which ascribes to one animal habits which are impossible to it and which belong to a totally different animal. He then proceeds to speculate, from these false premises, as to "the limits of evolution under the influence of natural selection"; and, naturally enough, in his efforts to reconcile the irreconcilable, finds himself reduced to the necessity of "begging the question." He would have saved himself all this trouble and perplexity if, in describing the *habits* of the animal, he had written *salamander* wherever the word *gopher* now appears in his paper.

Very respectfully, C. C. BYRNE,
Surgeon United States Army.

WASHINGTON, D. C., *January* 4, 1889.

THE WAYS OF BEES.

Editor Popular Science Monthly:

SIR: I see that you too have copied that "bees and pigeon race hoax," in your notes on page 287 of the December number, when "twelve bees, having been rolled in flour to mark them, and twelve pigeons belonging to a fancier in the village, were let loose about a league away. The first bee reached home a quarter of a minute before the first pigeon, and the rest of both squads arrived at the same instant, a few moments afterward." This is a *canard*. Take bees three miles from home and liberate them, and they will rise and *circle round* the place where they find themselves till they mark the location; then they will fly away in search of food, and, when they are loaded, will *return to the spot they left*, not to their old home, three miles or so away. Respectfully yours,

MAHALA B. CHADDOCK.

VERMONT, ILL., *January* 10, 1889.

[The item in question was translated from "La Nature," of September 8, 1888; a journal that is not usually careless in scientific matters.—ED.]

EDITOR'S TABLE.

WHAT MAKES SUCCESS IN LIFE.

WHEN the storm of the French Revolution was over, the Abbé Sieyès, who had taken a prominent part in it at the outset, was asked, somewhat in derision, what he had done in that critical time. "*J'ai vécu*," was his reply: "I lived through it." This, indeed, was no mean success for any actor in that bloody drama; and the philosophical abbé might well take a little pride in the adroitness that had enabled him to keep his head on his shoulders. Taking a broad view of the matter, survival is the best test of success; but then survival may either be of the whole or of a part only, of much or of little. The man may survive as a living organism—a zoölogical specimen—but character may be gone, or hope, or health, or happiness. The truly successful are they who carry with them to the end that which makes life worth living, who retain the sense of a purpose and meaning in life, and who do not, like James Mill, father of John Stuart Mill, feel that, when the freshness of youth is past, human existence is a somewhat dreary thing.

To the multitude perhaps success in life is gauged by a money scale: to be rich is to be successful, to be poor is to be unsuccessful; but this is far from being a desirable standard to erect. But few can reap success according to this idea; and the rest must reap failure and discontentment. A truer and better conception is that the man who develops his faculties and cultivates his dispositions aright, who, amid the warfare and vicissitudes of life, keeps his judgment sound, his aims sincere, his temper sweet, his domestic and social relations duly adjusted, and who thus in a true sense *lives* through his whole career, is the type of a successful man. The Roman poet Horace, whose good sense strikes us at every turn, must have had this idea to some extent; since the thought with which he feels he could satisfy himself were his existence to be suddenly brought to a term is that expressed in the word "Vixi," the exact equivalent of the Abbé Sieyès's "J'ai vécu," "*I have lived.*"

The education, then, that we want is an education for life; we want to be taught how to live, how to make the best of ourselves, of our circumstances, of our relations, of our environment generally. Is this the type of education prevalent in the present day? We fear not. The dominant idea in most—we might almost say in all—of our schools is that of a purely selfish success, which means, if realized, a quite incomplete success, one that leaves the general life of the man or woman essentially unblest. What our young people need above all things to be taught is to know themselves and their surroundings, and to understand the true objects of life. They want an education dominated by common sense and right motive; and the few who get such an education are not likely to fail of success in any sense. It is a great thing to be taught the simple habit of verification: one who has this will score many a point even in the competition of the market-place. It is a great thing to be taught, with conviction, that a well-regulated life is always worth living, and that this world is worth doing justice to. Many are stranded in mid-life simply because they have not taken things seriously enough, because they have trusted to chance rather than to doing with their might what their hands found to do. No time is unsuitable for overhauling one's scheme of life, and trying to find out its weak places if it has any; but perhaps the beginning of a new year offers the greatest advantages for such a review. All should aim at a true success in life; and a true success is within the reach of all, if prudence but take the helm.

COMPETITION.

The article by Mr. George Iles, which we publish in our present number, draws attention to the economic waste resulting from unrestricted competition, and suggests the action which the State may hereafter be compelled to take, in the public interest, to check the undue greed of individuals and corporations. Competition, as it seems to us, is not a thing which there is any use in opposing or condemning. It is simply, in the last resort, individual self-assertion; and as long as there are individuals they will assert themselves. Sometimes it occurs to a number of individuals that they can assert themselves—i. e., promote their own interests—more effectually by uniting their means and their efforts than by acting in complete independence of one another: then we have combination or co-operation; but the consolidated body still has its own competitors and its own battles to fight. From this we gather that there are certain unnecessary forms or modes of competition, and that experience points out, from time to time, what these are; but that competition, in the broad sense, is as lasting as human nature. Now, if we differ at all from our respected con-

tributor, it is where he suggests governmental interference to check certain apparently unhappy results of private enterprise. We do not see how the Government is going to help us in the least; and, as it happens, the interference that our contributor invokes is actually for the purposes of *restoring* competition in cases where he supposes it to have been arbitrarily arrested. He thinks that all trusts whose object is simply to raise prices by restricting competition should come under a legislative or judicial ban. To us the idea of forcing people to compete by legislative authority, whether they wish to do so or not, is a trifle extravagant. To our apprehension the best thing the State can do is to let the whole business alone, and leave individuals to find out for themselves under what circumstances competition is the only possible *régime*, and under what circumstances co-operation will serve a better purpose. It is not in the least likely that mankind at large is going to pay tribute to any serious extent to great corporations. Even an increase in prices is not a sure sign that the public is suffering, since the consolidation that has rendered the increase possible may have liberated a vast amount of capital and thrown it into more productive channels. Extremely low prices are too often the concomitant of business disorganization and the destruction of capital. The *régime* of freedom is the one that will suit us best. Give us freedom, and we can take care even of the trusts. A community that has been taught to depend on private initiative, and where legal *privilege* is unknown, has nothing to fear from any quarter.

THE article by Mr. J. M. Arms, on "Natural Science in Elementary Schools," in this number of the "Monthly," contains a notably clear and vigorous statement of the worth of real science-lessons to young pupils, together with some practical aid for teachers in giving such lessons, and a sketch of the growth of the sentiment in favor of science-teaching. This growth was undoubtedly aided by the attitude on the matter taken by the American Association for the Advancement of Science, which, at its meeting in 1879, appointed a committee, of which the former editor of this magazine was chairman, to consider the subject of "Science-Teaching in the Public Schools."

The report of this committee was presented to the Association at the Boston meeting in the following year. It was drawn up by the chairman, and takes the ground that the quality of the science-teaching, where there was any in the public schools at that time, was generally so unsatisfactory that it ought to be entirely recast before any extension of it would be desirable. A point to which Prof. Youmans called special attention is, that science was being taught by the old methods devised for other subjects, which were entirely unsuitable for the new study. In the words of the report, "Through books and teachers the pupil is filled up with information with regard to science. Its facts and principles are explained as far as possible, and then left in the memory with his other school acquisitions. He learns the sciences much as he learns geography and history. Only in a few exceptional schools is he put to any direct mental work upon the subject-matter of science, or taught to think for himself." The deceptive quality of oral lessons, alluded to by Mr. Arms, is thus pointed out in this report: "Instruction in elementary science is now," when the pupil enters the grammar school, "to be carried on by what is known as oral teaching. This method, as extensively practiced in the grammar grades of the public schools, is everywhere growing in favor, and we are once more told that it is a successful revolt against book-studies. It is chiefly applicable to the sciences, and its cardinal idea is in-

struction without a text-book. This looks fair, but it is delusive. The method does not remove the book that the pupil may come at the phenomena, but it removes the book that the teacher may take its place. Oral teaching is class instruction, in which information is imparted in a familiar manner, with the view of awakening the interest of the class. But, so far as real science is concerned, it is doubtful if this method is not worse than the one it replaces. . . . The value of educational systems consists simply in what they do to incite the pupil to help himself. Mechanical school-work can give instruction, but it can not develop faculty, because this depends upon self-exertion. Science, if rightly pursued, is the most valuable school of self-instruction. From the beginning, men of science have been self-dependent and self-reliant because self-taught; and it is a question whether they have been most hindered or helped by the schools."

LITERARY NOTICES.

THE EULOGY OF RICHARD JEFFERIES. By WALTER BESANT. New York: Longmans, Green & Co. Pp. 384. Price, $2.

THE name of the subject of this book may not be familiar to all the readers of the "Monthly." An insight of the quality of the man may, however, be given by the fact that Mr. Besant started to write his life without ever having seen him, and ended by calling the biography a eulogy. Mr. Jefferies was born in 1848, and died in 1886, only thirty-eight years old, and in only ten of those years did he do work suitable to his powers and fitted to bring him recognition; but the work of those ten years has given him a place among students of Nature and masters of English writing alongside of Gilbert White and Thoreau. We doubt if he has ever had a rival as an accurate describer of Nature in her various aspects and minute details, who could at the same time command the sympathies of the reader in what almost runs into "cataloguing." His early surroundings and training were most favorable to the cultivation of those habits of close observation which he brought into play in his later writings, and it was his misfortune that he spent so many of his few years in vain efforts to do what he was not fitted for. Mr. Jefferies was born, being descended from a long line of independent farmers, at the farm-house of Coate, near Swindon, in Wiltshire, in a country of downs and abounding in ancient monuments. Of the territory around the old house he knew "every inch of ground, every tree, every hedge," and the land of it which lies within a circle of ten miles radius "belongs to his writings." The family "seem to have inherited, from father to son, a love of solitude and a habit of thinking for themselves." Richard's father, who is drawn in his books as Farmer Iden, and a man of this sort, "took him into the fields and turned over page after page with him of the book of Nature, expounding, teaching, showing him how to use his eyes, and continually reading to him out of that great book." He early showed an inclination to literature, and the position as reporter on two or three of the local newspapers enabled him to make a kind of a living while he tried to write novels, work for which he had none of the essential qualifications. The account of his life for several years is a record of ambitious attempts, high hopes, and bitter disappointments, as story after story was submitted to publishers and refused. His first success came in 1872. The relations of the farmer with the agricultural laborer had become a living question, and Jefferies, feeling that he knew all about the subject, wrote a long letter upon it, which was published in the "Times," with an accompanying "leader," and was answered and commented upon in other journals. In the next year he published an article in "Fraser's Magazine" on "The Future of the Farmer," and that attracted attention. It was followed by two other papers of similar character; and in 1876, Jefferies, having discovered his true field, began that series of papers which, afterward published in books, bid fair to give him a permanent place among the most famous descriptive writers of rural nature and of animal and plant life. The first book, "The Gamekeeper at Home," secured him recognition at once, and brought proposals from publishers. Among others, Mr. Longmans invited him to write a book

on "Shooting." He could not do it, because he could not work up ideas that were not of his own originating; but the thought was the seed of "The Badminton Library." The character of his later books is correctly described by Mr. Besant when he says that in them "the whole of the country life of the nineteenth century will be found displayed down to every detail. The life of the farmer is there; the life of the laborer; the life of the gamekeeper; the life of the women who work in the fields and of those who work at home. He revealed Nature in her works and ways; the flowers and the fields; the wild English creatures; the hedges and the streams; the wood and the coppice. He told what may be seen everywhere by those who have eyes to see," and he began "to write down the response of the soul to the phenomena of Nature, to interpret the voice of Nature speaking to the soul. . . . He draws as no other writer has done the actual life of rural England under Queen Victoria." The secret of the perfect execution of these works is found in examining the note-books which he habitually kept, recording daily observations and phenomena, a few specimens of which are printed, and the reading of which "is like reading an unclassified index to the works of Nature." Jefferies was disabled by illness during the last five years and a half of his life, and had to work by the hands of others. Yet some of his best essays were produced during this time. Among them were "The Red Deer," a minute account of the natural history, etc., of these animals, to observe which he had gone all over Exmoor on foot; and the essay entitled "The Pageant of Summer," in which he reached his highest point, but which "was written while he was in deadly pain and torture." He died poor, and a subscription was taken among the admirers of his writings to place his family in a comfortable position.

BURIAL-MOUNDS OF THE NORTHERN SECTIONS OF THE UNITED STATES. By CYRUS THOMAS, Ph. D. Washington: Bureau of Ethnology. Pp. 119.

THIS monograph is an advance extract from the fifth annual report of the Bureau of Ethnology. It deals with the burial-mounds of the Wisconsin, Illinois, Ohio, and Appalachian districts, which areas are regarded as having been occupied by different tribes. The effigy-mounds form the distinguishing feature of the Wisconsin district. The works of the Illinois region are mostly small conical tumuli, containing rude stone or wooden vaults, and further characterized by the scarcity of pottery vessels, the frequent occurrence of pipes, the presence of copper axes, etc. Among the peculiar features of the works in the Ohio district are the great circles and squares of the inclosures, the long parallel earthen walls, the so-called altars within the mounds, and the numerous carved stone pipes. The mounds of the Appalachian district resemble those of the last-named area, in containing altar-like structures and numerous stone pipes. The peculiar features are the mode of burial, the absence of pottery, and the numerous polished celts and engraved shells found in the mounds. The other regions mentioned but not treated in this monograph are the New York, middle Mississippi, lower Mississippi, and Gulf districts. This districting, however, is put forward as a working hypothesis rather than as an established arrangement. Prof. Thomas gives brief descriptions of the leading types found in the different northern districts mentioned, confining himself chiefly to the explorations made by the bureau assistants. These accounts are illustrated with forty-nine cuts and six plates. He concludes, from the results of these explorations, that each of the tribes inhabiting one of these northern districts had several modes of burial, differing with the social position of the deceased; that the custom of removing the flesh before the final burial was quite general, the bones of the common people being often gathered into heaps over which mounds were built; that usually some religious ceremony in which fire played a part was performed at the burial, but that there is no evidence of human sacrifice; that nothing in the character or contents of the mounds indicates that their builders had reached a higher culture status than that in which some of the Indian tribes were found at the coming of the Europeans; that the beginning of the mound-building age does not antedate the fifth or sixth century; and that the custom of erecting mounds over the dead continued in some localities into post-Columbian times.

AN INTRODUCTION TO ENTOMOLOGY. By JOHN HENRY COMSTOCK. With many Original Illustrations, drawn and engraved by ANNA BOTSFORD COMSTOCK. Part I. Ithaca, N. Y.: The Author. Price, $2.

PROF. COMSTOCK designs that this work shall enable students to acquire a thorough knowledge of the elementary principles of entomology, and to classify insects by means of analytical keys similar to those used in botany. As the completion of the work has been delayed by other duties, the author has thought best to issue this part by itself. The first three chapters are of an introductory character. In Chapter I the general characters and metamorphoses of insects, which term the author restricts to the *Hexapoda*, are stated; Chapter II is a description of the anatomy of insects, fully illustrated; and Chapter III is devoted to the classification of the *Hexapoda*. The remaining chapters consist of descriptions of the more common or conspicuous species in each family, together with keys by means of which the student can readily determine to what family any insect of which he has a specimen belongs. In many cases tables of genera are also given. Much space has been devoted to accounts of the habits and transformations of the forms described. The needs of agricultural students especially having been kept in view, those species that are of economic importance have been described with considerable fullness. The rest of the work will be published as soon as practicable. In addition to the systematic part, in which four more orders—*Lepidoptera*, *Diptera*, *Coleoptera*, and *Hymenoptera*—remain to be described, there are to be chapters on the means of destroying insects or of preventing their ravages, on the collection and preservation of entomological specimens, on entomological supplies, a classified list of entomological works, a glossary, and an introductory chapter. This part comes in paper covers. It is well printed, and is abundantly illustrated.

GLEANINGS IN SCIENCE: A Series of Popular Lectures on Scientific Subjects. By GERALD MOLLOY, D. D., D. Sc. London and New York: Macmillan & Co. Pp. 352. Price, $2.25.

WITH one exception, the lectures which make up this attractive volume were delivered before the Royal Dublin Society. In preparing them for publication the author has used whatever materials have come into existence since the lectures were delivered, so as to present the latest available information in each case. The subjects treated are included in the sciences of heat and electricity, except the Alpine glaciers, which are described in a lecture delivered to a young men's society. There are two lectures on the modern theory of heat as illustrated by the phenomena of latent heat, one of these dealing with the latent heat of liquids, the other with the latent heat of vapors. Lightning and thunder are treated in one lecture, lightning-conductors in another, and the storing of electrical energy in a third, while the recent controversy in England on lightning-conductors is sketched in an appendix. The electric light is the subject of two lectures; one telling how the electric current is produced, the other how the current is made to yield the light. Two lectures also are devoted to the sun as a store-house of energy: one describing the immensity of the sun's energy, the other discussing the theories as to its source. The treatments are thoroughly popular, avoiding mathematics and technical language, and, besides setting forth the present state of the science in each case, touch upon the history of the subjects and the practical applications of the principles stated. Descriptions of experiments are introduced, which the reader is helped to realize by many excellent illustrations. The lecture on "The Glaciers of the Alps" is especially fascinating, and owes part of its interest to the quotations and cuts borrowed from Mr. Whymper's "Scrambles among the Alps." The whole volume, in manner as well as in matter, reminds one of Tyndall's popular works, and will be found very attractive reading for any one who has an intelligent interest in science.

THE CIVILIZATION OF SWEDEN IN HEATHEN TIMES. By OSCAR MONTELIUS, Ph. D. Translated by Rev. F. H. WOODS, B. D. London and New York: Macmillan & Co. Pp. 214. Price, $4.

As in most countries, the archæological chronology of Sweden embraces a stone, a bronze, and an iron age. The stone age is regarded as extending to about 1500 B. C. In his chapter on this period the author describes a considerable variety of tools and

weapons of stone which have been dug up in Sweden, and tells how archæologists have proved that such articles could be made without the use of metals. He sets forth also what information these relics afford as to the customs and habits of the people who made them. The graves belonging to the same period are also described. It appears that the Swedish common people of later times, finding these stone implements, called them "Thor's bolts," and regarded them as a sovereign protection against lightning-strokes and other disasters. "Even at the present day it is often impossible to induce people to sell antiquities of stone, because they believe that by so doing they lose a protective amulet." The articles which characterize the bronze age, extending from about 1500 to 500 B. C., were nearly all formed by casting; it is only toward the close of this period that traces of the use of the hammer in working the metal are found. While some effort toward ornamentation appears in the relics of the stone age, much more scope was given to this taste when metal came into use. The works of the earlier part of the bronze age are decorated with fine spirals and zigzag lines; those of the later part of this period do not display spirals of the same shape, but the ends of rings, knife-handles, etc., are often rolled up in spiral volutes. Prof. Montelius, in another work, has distinguished six subdivisions of the bronze age, but does not take space here to state the data on which they are based. Articles of horn, bone, wood, and leather, belonging to this period have been found, and even woolen clothing which had been buried in oak-tree coffins. The iron age is reckoned from 500 B. C. to near 1100 A. D., and is treated in four subdivisions. The author is convinced that the arts of working both iron and bronze were learned by the inhabitants of Sweden by intercourse with other nations, and not brought into the country by any immigration of a new people. The relics of this age which have been found are of great variety, and many of them bear decorative figures much more elaborate than those on the bronze implements, and include some very pleasing designs, while inlaying and plating with silver and gold were also practiced. A large number of stones bearing inscriptions in Runic letters date from this period. A map and two hundred and five cuts illustrate the text. Both this work and Dr. Molloy's "Gleanings in Science" would be more valuable to students if they were provided with indexes.

THE HOME-MAKER. A Monthly Magazine. Edited by MARION HARLAND. Vol. I, No. 1. October, 1888. New York: The Home Maker Company. Price, 20 cents a number; $2 a year.

"THE HOME-MAKER" has an honorable and important field. A moment's reflection will call to mind a host of ways in which the character of the home acts upon the comfort, habits, health, dispositions, manners, morals, and culture of the inmates—directly by its effect upon them while at home, and perhaps indirectly by driving them to seek pleasure away from home. Much can be done to improve the character of the home by the teachings of a good magazine. A home modeled after the pattern of "The Home-Maker" would be a nice, comfortable, pretty, refined place, with much leisure and little care. Such a place would insure the wife and mother being always happy; would give the children soft and pleasant surroundings to grow up in, and would offer to the husband the most complete contrast to the hard, anxious struggle of his daily business. This magazine is adapted especially to ladies in comfortable circumstances who wish to know how to beautify their homes, and how to free housekeeping of its inconveniences. Nearly all the articles are adapted for their guidance or entertainment. But not all. The editor says that the masculine element is essential to the right composition of a home, and, beginning in the second number, this element is represented by a series of "Talks about Photography," by Mr. Alexander Black. The contents of the first number comprise editorials, an illustrated description of "Some Old Virginia Homesteads," two stories, a charade, some poetry, practical articles on "Birds and their Care" and "Cheap Living in Cities," and departments of house-work, fancy-work, games, the nursery, the care of the aged, household health, fashions, window-gardening, and book notices. The third issue is a Christmas number, and its contents are adapted to the season. Christine Terhune Herrick and Grace Peckham, M. D., are as-

sociate editors, and among the other writers are Olive Thorne Miller, Catherine Owen, Lucy C. Lillie, Margaret E. Sangster, and Rose Terry Cooke. The paper and printing of the magazine are of excellent quality, and the illustrations are numerous and have a very pleasing effect.

GARDEN AND FOREST: a Journal of Horticulture, Landscape Art, and Forestry. Conducted by Prof. CHARLES S. SARGENT. Published weekly. New York: The Garden and Forest Publishing Company. Price, 10 cents a number; $4 a year.

WITH its last number for 1888, "Garden and Forest" closes its first volume, which began with the issue for February 29th. This journal, at its first appearance, took rank as a thoroughly competent and progressive representative of the arts to which it is devoted, and this character has been ably maintained. A glance at the index of Volume I shows that an immense variety of plants has been described, and a large number of other subjects has been treated in the forty-four numbers that have already appeared. "Garden and Forest" is not a florists' and nurserymen's trade-journal, but, while giving the dealers in flowers and trees, and also the fruit-growers, much scientific information of value to them, it has an interest also for the botanist, and for him who has the arrangement of public or private grounds. The departments represented in each issue are: editorials, English correspondence, new or little-known plants (illustrated), cultural department, the forest, correspondence, recent publications, and notes. Other subjects which have been given a place from time to time are: horticultural exhibitions and conventions, entomology, and the management of public parks. Each number contains three or four illustrations, one being always a portrait of some unfamiliar but valuable plant. Among the writers for this journal besides the editor, who is Director of the Arnold Arboretum and Professor of Arboriculture in Harvard College, are W. G. Farlow, Sereno Watson, B. E. Fernow, C. G. Pringle, C. C. Abbott, and William Falconer in this country, and W. Watson, George Nicholson, and W. Goldring in England. It is seldom that a periodical appears which is so well deserving of a long and prosperous life as "Garden and Forest."

The most extended paper in No. 2, Vol. II, of the *Journal of Morphology*, is "On the Development of *Manicina Areolata*," by Henry V. Wilson, Fellow of the Johns Hopkins University. It is the result of study of these corals in the spring of 1887 at the marine laboratory of the university, which was then stationed on the island of New Providence, Bahamas, supplemented by investigations made at the biological laboratory in Baltimore. The text is illustrated with seven plates. R. W. Shufeldt, M. D., contributes two monographs: the first being "Further Studies on *Grammicolepis Brachiusculus*, Poey," a fish of which only one specimen is known to naturalists; and the other being "On the Affinities of *Aphriza Virgata*," the popular name of which is the surf-bird. Both these papers deal with the osteology of the subjects. The former is accompanied by fourteen woodcuts and the latter by a plate. "The Structure and Development of the Visual Area in the Trilobite, *Phacops Rana*, Green," is described by John M. Clarke, with a plate; and Prof. E. D. Cope has a paper in this number entitled "On the Relations of the Hyoid and Otic Elements of the Skeleton in the Batrachia," with three plates.

In *The Journal of Physiology*, Vol. IX, No. 4 (Cambridge, England, Scientific Instrument Company), J. S. Haldane, M. A., M. B., presents a brief account of investigations on "The Elimination of Aromatic Bodies in Fever." There is another brief paper by Vincent D. Harris, M. D., and Howard H. Tooth, M. D., "On the Relations of Micro-organisms to Pancreatic (Proteolytic) Digestion"; and a "Note on the Elasticity Curve of Animal Tissues," by Charles S. Roy, M. D., F. R. S., with a plate. The most extended paper in this number is "On the Nature of Fibrin-Ferment," by Prof. W. D. Halliburton, M. D., who states, as the principal result of his researches in this direction, that "the fibrin-ferment, whether it be prepared by Schmidt's or Gamgee's method, is a globulin derived from the disintegration of the white blood-corpuscles and identical with a proteid I have previously named cell-globulin, which is the principal proteid contained in the cells of lymphatic glands." This number contains also a communication on "Some Points in the Physiology of Gland

Nerves," by J. Rose Bradford, D. Sc. Nos. 5 and 6 form a double number, which contains three papers: "On Digestion in Hydra, with some Observations on the Structure of the Endoderm," by M. Greenwood, with two plates; "On the Phenomena of Inhibition in the Mammalian Heart," by Prof. John A. McWilliam, M. D., with two plates; and "On the Normal Duration and Significance of the 'Latent Period of Excitation' in Muscle-Contraction," by Prof. Gerald F. Yeo, M. D., with cuts of tracings.

Proceedings of the United States National Museum, Vol. X, 1887, consists of technical descriptions of fishes, birds, etc., illustrated with thirty-nine plates and a number of text-figures. Appended to the volume is a "Catalogue of the Contributions of the Section of Graphic Arts to the Ohio Valley Centennial Exposition, Cincinnati, 1888." These contributions represent processes of engraving and printing for pictorial purposes from the sixteenth century to our own time, wood-engraving in the United States, etching in the United States, and modern photo-mechanical processes.

The Report of the Entomologist, of the Department of Agriculture, Prof. *Charles V. Riley*, for 1887, is devoted chiefly to an article by L. O. Howard on the chinch-bug, giving a complete account of the species, and an article on the codling moth by the same writer. The use of the kerosene emulsion, the only recently devised remedy for the chinch-bug of any importance, is treated in some detail in the first article. Other papers accompanying the report relate to silk-culture, scale-insects, and other locally noxious species, apiculture, etc. The report contains eight plates, showing the insects treated of, methods of fumigation, and the Cattaneo mulberry-tree.

In *The Cat and its Diseases*, Dr. *E. M. Hale*, of Chicago, has published a useful and convenient paper on this animal of highly domestic habits and the treatment which it is entitled to receive. Brief accounts are given of the origin and history, traits, and varieties of the cat. Under the heading of "Health of Cats" are discussed their food, including grass, their drink, housing, and the care of their fur. Several diseases are described, and the special treatment that should be given for each.

The report on *Mineral Resources of the United States*, 1887, by *David T. Day* (United States Geological Survey, 50 cents), is the fifth of the series on this subject. It extends the information contained in the previous volumes to include the calendar year 1887. The statistical tables have been brought forward, but with this exception only such information as is supplementary to the previous volumes should be looked for. The principal statistics concerning the more important substances have already been published in special bulletins. From this report it appears that not only was the production of iron and steel in the United States very much larger in 1887 than in the previous year, but we consumed virtually all that we produced, besides many thousand tons of old iron worked over, and imported more than in any other year except 1880. For several years we have consumed more iron and steel than any of the great European countries. Our production of gold shows a decrease of about two million dollars from 1886, while silver shows an equal increase. During the greater part of the year the copper market was very dull, yet our production shows an advance over the highest previous figures. The output of lead went far ahead of the largest previous quantity. Zinc also shows an increased production. While there was practically no production of pure aluminum in 1887, the amount of aluminum bronze produced has risen from 4,000 or 5,000 pounds in 1885 to 144,764 pounds in 1887, and the amount of ferro-aluminum from 2,500 pounds in 1886 to 42,617 in 1887. The total production of all kinds of commercial coal shows a marked increase, owing partly to the near-by use of natural gas, stimulating coal to seek more distant markets, and partly to the advance in the iron manufacture. The restriction of the output of petroleum in the Pennsylvania and New York fields was compensated by the increase in the Ohio field, with some help from West Virginia and California. The consumption of natural gas can be got at only approximately. The amount of other fuel displaced by it, estimated at the value of less than five million dollars in 1885 and ten millions in 1886, had risen to over fifteen millions in 1887. The value of the precious stones produced in the

United States is not an important item, being estimated at only $88,600 in 1887. The production of salt shows a slight advance, while that of mineral waters appears to have been stationary.

The chemist who would profit by *A Correlation Theory of Chemical Action and Affinity*, by *Thomas Wright Hall*, M. D. (Remington & Co., London, 7*s.* 6*d.*), must first learn a new dialect, for the author's strange conceptions are made still harder to grasp by his eccentric language. We are not certain that the present generation is prepared to profit by this book, even if the language were as clear as the "Dayshine," whose influence the author rates above all other forces. "If you narrow and dwarf," says he, "the Photothermal Force to heat and light alone, or to cold and shade alone, or to the petty needs and feelings of Man, or to the ken of his workshops, of his pyrometers, thermometers, photometers, then, indeed, is the August Photothermal Force or Firemight shorn of its true and boundless majesty and value. Not so, however, if it dawn in Science that the sidereal and the planetary shine powers are the Giant Springs of the Firemight which in oscillatory static balance with each other in *actual* Ethero-molecular matter, and in free Ether evolve the Quintessential Form and Photothermality of the Earth—evolve the Dayshine and Nightshine and the Shapes and colored Loveliness of our Home, the Earth." The above sample will show the character of the book better than a long description.

Mr. *James E. Talmage's First Book of Nature* (The Contributor Company, Salt Lake City) is a little volume embodying a brief description of the animal, vegetable, and mineral kingdoms and the heavens. The doctrine of evolution is not referred to in its pages. The complexion of the book has been determined by the author's desire to show that "Nature is but another name for the will of God as expressed in his works." The volume is illustrated, and is adapted to the reading of young people.

Although relating largely to the election of 1888, *True or False Finance* (Putnam, 25 cents), in the "Questions of the Day Series," presents the subject of taxing imports on a basis which has a permanent interest—i. e., as a question of raising revenue. The author starts with the proposition that a true system of finance will enable a government to adjust its revenue to its expenditures without the slightest difficulty. He then shows how the growth of commerce has made former tariff exactions enormous at the present time, and gives the ways proposed by protectionists for getting rid of the surplus now in our treasury. The Democratic policy is next stated, the Mills Bill is described, and the effects it would have on the workman, the farmer, the wool-grower, and the country at large are told.

No. 10 of *Shoppell's Modern Houses* (Co-operative Building Plan Association, New York, 25 cents) has come to hand. It contains designs for twenty-one dwellings and a bank, giving in each case a perspective view, floor-plans, and a brief description. The cost of carrying out these designs is stated in each case, and ranges from $500 to $15,000. Some general advice on building is given and information concerning the plans, specifications, estimates, etc., which the "Association" is prepared to furnish to those about to build.

Miss Parloa's New Cook-Book (Estes & Lauriat) comes to us in the form of a large-paged pamphlet, crowded with recipes, briefly worded and in small type. A great variety of dishes is described in each of the divisions of soups, fish, meats, vegetables, pies and puddings, cake, dessert, etc. Miss Parloa's name is sufficient guarantee for the excellence of the book.

A Code of Morals, by *John S. Hittell* (The Bancroft Company), is a little didactic treatise, modeled after the manuals of Epictetus and Marcus Aurelius. "Standing on the shoulders of the eminent men who wrote those immortal books," says the author, "making use of their labors, and striving to appropriate the knowledge of our time and to put myself in harmony with its spirit, I have here tried to do for my age what they did for theirs." The manual consists of forty-five brief sections on separate topics, grouped in five chapters, viz., on individual duties, social, industrial, political, and religious duties.

Die Gegenwart (The Present) is a German monthly, twenty-four-page periodical, for the people, devoted to the discussion of

questions of the times, entertainment, and instruction, published at Chicago by Th. G. Steinke. With the January number for 1889 it entered upon its second volume. Subscription price, $1 a year.

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POPULAR MISCELLANY.

M. Chevreul's New-Year's-Day.—M. Chevreul, who was a hundred and two years old on the 31st of August last, had a happy New-Year. According to an authentic account of his present daily life, given in "La Nature," he awakes at five o'clock in the morning, and is served a few minutes afterward with a warm broth, which he takes with a relish. While resting in bed he reads the papers, and then receives a few visits, particularly one from his *preparateur*, M. Arnaud. At eleven o'clock, still in bed, he takes a plentiful breakfast of soup, meat, and *café au lait*, with much bread and butter. At one he rises, dresses, and is ready to take the air for two hours. Conducted by his faithful coachman, Joseph, who has been in his service for twenty years, he often drives to the Monceau Park; but his favorite excursion is to the Eiffel Tower. Returning at five o'clock, he takes a glass of milk and goes to bed. He dines in bed at seven o'clock, with a good appetite, drinking nothing but water. After dinner, he sleeps soundly; and when M. Arnaud asks him in the morning, as he always does, if he has enjoyed a good night's rest, he replies that he has never had any other kind. M. Chevreul is living with his son, and enjoys the devoted and intelligent care of his old servant Denise, who has been with him for fifty years.

The Australasian Association.—The first meeting of the Australasian Association for the Advancement of Science was held at Sydney, beginning August 28th, under the presidency of Prof. Black. About eight hundred and fifty members were present, and one hundred and ten papers were sent in. One of the topics discussed in the presidential address was the place of chemistry in education. The accounts of the sectional meetings are scanty. We find mentioned in the Chemical Section, the papers of Mr. Dixon, on "The Formation of Coal," in which the different qualities of the mineral were ascribed to different kinds of vegetable matter of which it is composed; of Mr. Smith, on "Butterine," which was well spoken of; of Mr. Mingaye, on the "Discovery of Tellurium in Certain Bismuth Ores" in New South Wales; of Mr. Edgar Hall, on "Silver Smelting," etc., which was exceedingly well received; of Mr. W. Skey and Mr. Don on "Gold" in the Australian reefs; and of Mr. J. H. Maiden, on the "Chemistry of Indigenous Australian Products." The formation of this association was suggested in 1879, begun in 1884, and completed at this meeting, which was held in connection with the one hundredth anniversary of the foundation of the colony of New South Wales; and was most actively promoted by Prof. Liversidge. The scheme of its organization has been so arranged as to make it truly representative of all the Australian colonies. Each learned or scientific society may have one representative in the Council for every hundred of its members. The Presidents of the Royal Societies of the several colonies are among the vice-presidents. The presidents of sections were all selected from other colonies than New South Wales, while the secretaries were, of course, residents of the place of meeting, Sydney. It is understood that the meetings are to be held in rotation

through the colonies, and the officers chosen accordingly. The meeting for 1889 is to be held in Melbourne, with Baron Sir Ferdinand von Müller as president; and the meeting for 1890 will be in New Zealand.

Habits of the Red Squirrel.—Dr. R. Bell, of the Canadian Geological Survey, says that over more than one half of its range, the chickaree, or red squirrel (*Sciurus Hudsonius*, Pennant), lives chiefly on the seeds of the black and the white spruce, and evidently thrives on this diet. "Their mode of obtaining a supply of cones is ingenious. The cones grow principally at the tops of the spruce-trees, and the largest and finest are always to be found there. The chickaree selects a tree which, either from the steepness and density of its upper part or from its leaning to one side, makes it certain that the cones, if detached, will fall to the ground; then he cuts off the heavily laden twigs and lets them drop. This is done with an impatient rapidity. Should a person be sitting quietly under a tree while one of these busy little creatures is at work at the top, he will see the bunches of cones come tumbling down in such quick succession that he might suppose half a dozen squirrels were at work instead of only one industrious little fellow. These bunches seldom lodge in the branches below, but should the squirrel on his way down (after having cut off a satisfactory supply) notice one of them arrested in a hopeful position toward the extremity of a bough, he will sometimes run out and give it a second send-off. In climbing tall spruce-trees for observations of the surrounding country, I have often noticed bunches of cones lodged where, if started off a second time, they would be certain to catch again in the thick branches before reaching the ground. The squirrels seem to understand the situation perfectly, and they leave such bunches to their fate, probably arguing that it would be easier for them to cut off fresh ones than to trouble themselves further about property lost beyond hope of profitable recovery—a piece of wisdom which the most successful business men have also learned to follow. The chickaree, having thrown down a sufficient stock for a few days' use, proceeds to carry them, as required, to his favorite feeding-place near by. I have occasionally noticed a squirrel feeding with a fresh cone lying beside the one he was actually dining off, as if it were waiting to be attacked the moment he got through with the first. They peel off the scales in succession, and nibble out the seeds with great rapidity. They leave their stock lying about under the tree, and only carry off one or two cones at a time. A little drying causes the scales to gape, and so facilitates the opening process."

Protection of Piles against the Teredo.—A series of experiments has been made in San Francisco Harbor on the best method of protecting piles against the attacks of the teredo. Five methods of preparation were tried, viz.: Jacketing with sewer-pipe and filling the space between pile and pipe with concrete of sand, gravel, and Portland cement; covering with asphaltum and wire cloth; washing, in four coats, with a secret marine cement that contained an extremely poisonous substance of great efficiency; washing with Portland cement and other secret ingredients; and covering with burlap and a paste of naphtha, carbon bisulphide, limestone, kaolin, sawdust, and sulphur. The treated piles were all barked. Besides these, some piles in the natural condition, untreated but covered with their bark, were driven down. Of a number pulled for examination after about four years, all of the treated piles except those prepared by the first method were hopelessly riddled by the teredo, and only one was strong enough to be removed without breaking, while the untreated ones were only slightly attacked, and were practically as sound as ever. The coatings applied by the various experimenters, depending upon their adhesion to the pile, utterly failed to afford even the protection given by the bark. The result agrees with experiments made in other places. Inclosing with drain-pipes and packing with concrete affords adequate protection, but the expense of the method—thirty dollars a pile—makes it unavailable.

Bulgarian Wines.—It is only of recent years that the cultivation and production of the vine have attained any considerable proportions in Bulgaria. Formerly it was looked upon as a most unimportant industry. Now

there are about 172,000 acres of land under vine-cultivation in north and south Bulgaria. The yield of wine per acre varies between 250 and 350 gallons, two thirds of which is red wine and the remainder white. The wine in some vineyards is said not to be inferior to the best natural wines of other European countries. In 1886 some 140,000 gallons of wines were exported from southern Bulgaria to the south of France. There they were manipulated and sold as the products of the country. The phylloxera made its appearance a few years ago, but stringent measures were at once taken to stamp it out, and very strict regulations are enforced to prevent its return.

The Chemistry of an Egg-Shell.—The shell proper of an egg is made up mostly of earthy materials. The proportions vary according to the food of the bird, but ninety to ninety-seven per cent is carbonate of lime. The remainder is composed of from two to five per cent of animal matter and from one to five per cent of phosphate of lime and magnesia. Now, Mr. P. L. Simmonds asks, where does the hen procure the carbonate of lime with which to form the shell? If we confine fowls in a room, and feed them with any of the cereal grains, excluding all sand, dust, or earthy matter, they will go on for a time and lay eggs, each one having a perfect shell, made up of the same calcareous elements. Vauquelin shut up a hen for ten days, and fed her exclusively upon oats, of which she consumed 7,474 grains in weight. During this time four eggs were laid, the shells of which weighed nearly 409 grains; of this amount 276 grains were carbonate of lime, 17½ grains phosphate of lime, and 10 grains gluten. But there is only a little carbonate of lime in oats, and whence could this 409 grains of the rocky material have been derived? The answer to this question opens up some of the most curious and wonderful facts connected with animal chemistry. The body of a bird, like that of a man, is but a piece of chemical apparatus, made capable of transforming hard and fixed substances into others of a very unlike nature. In oats there is contained phosphate of lime, with an abundance of silica, and the stomach and assimilating organs of the bird are made capable of decomposing the lime-salt and forming with the silica a silicate of lime. This new body is itself made to undergo decomposition, and the base is combined with carbonic acid, forming carbonate of lime. The carbonic acid is probably derived from the atmosphere, or more directly perhaps from the blood. These chemical changes among hard inorganic bodies are certainly wonderful when we reflect that they are brought about in the delicate organs of a comparatively feeble bird, under the influence of animal heat and the vital forces. They embrace a series of decomposing and recomposing operations which it is difficult to imitate in the laboratory.

Fresh-Water Sponges.—The fresh-water sponges, according to Mr. Edward Pott's monograph, resemble in constitution and general appearance many of the sponges of a marine habitat, with the addition that they have gemmules or "seed-like bodies," which marine sponges have not. They are green, but may be distinguished from mosses and *Confervæ* by the difference between smooth, slender threads and leaves; by the presence of efferent or discharging apertures; and, with a lens, by their spicules—to which finding the spherical gemmules adds further confirmation. The green color varies according to the light, and may, in dark places, or dark parts of the sponge, be faded into nearly white, gray, or cream color; but some species are never green in the sunlight. These organisms have occasionally been discovered growing in water unfit for domestic uses; but as a rule they prefer pure water, and in the author's experience the finest specimens have always been found where they were subjected to the most rapid currents. "The lower side of large, loose stones at the 'riffs' or shallow places in streams; the rocks amid the foaming water at the foot of a mill-dam fall; the timbers of a sluice-way, the casing of a turbine water-wheel, or the walls of a 'tail-race' beneath an old mill—in all these places they have been found in great abundance and of a very lusty growth. Of all discouraging situations it is almost hopeless to look for them in shallow water having a mud bottom. . . . In any body of water liable to be charged with sedimentary material, the principle of natural selection favors those growing on the lower

side of their bases of support, which protect them from the intrusion of the heavier particles. For that reason perpendicular and water-logged or floating timbers, submerged stumps of trees, and branches drooping into the water from trees or bushes along the banks, are favorite locations. They do not disdain more temporary support, such as weeds and water-grasses. . . . Through the clear water of our Northern lakes we may often see them lying in slender lines upon the leaves of submerged weeds, or in beautiful, cushion-like masses upon the stones or gravel." The best season for collecting them is from July till late in November.

Geological Floras. — M. de Saporta's views on the origin of our forest-groupings were substantially concurred in by Prof. W. Boyd Dawkins, in his vice-presidential address before the Geological Section of the British Association. Having referred to the characteristic features of the earlier floras, much as M. de Saporta has done, and to the antiquity of the gingko (which has descended from the Carboniferous age), he says: "In North America the flora of the Dakota series so closely resembles the Miocene of Switzerland that Dr. Heer had no hesitation in assigning it in the first instance to the Miocene age. It consists of about one hundred species, of which about one half are closely allied to those now living in the forests of North America—sassafras, tulip, plane, willow, oak, poplar, maple, birch, together with sequoia, the ancestor of the giant redwood of California. The first palms appear also in both continents at this place in the geological record. In the Tertiary period there is an unbroken sequence in the floras, as Mr. Starkie Gairdner has proved, when they are traced over many latitudes, and most of the types still survive at the present day, but slightly altered. If, however, Tertiary floras of different ages are met with in one area, considerable differences are to be seen, due to progressive alterations in the climate and altered distribution of the land. As the temperature of the northern hemisphere became lowered, the tropical forests were pushed nearer and nearer to the equator, and were replaced by plants of colder habits from the northern regions, until, in the Pleistocene age, the arctic plants were forced far to the south of their present habitat. In consequence of this, Mr. Gairdner concludes that 'it is useless to seek in the arctic regions for Eocene floras as we know them in our latitudes, for during the Tertiary period the climatic condition of the earth did not permit their growth there. Arctic fossil floras of temperate and, therefore, Miocene aspect are in all probability of Eocene age, and what has been recognized in them as a newer or Miocene *facies* is due to their having been first studied in Europe in latitudes which only became fit for them in Miocene times. When stratigraphical evidence is absent or inconclusive, this unexpected persistence of plant-types or species throughout the Tertiaries should be remembered, and the degrees of latitude in which they are found should be well considered before conclusions are published respecting their relative age.' This view is consistent with that held by the leaders in botany—Hooker, Dyer, Saporta, Dawson, and Asa Gray—that the north polar region is the center of dispersal, from which the dicotyledons spread over the northern hemisphere."

Science and Trade-Routes.—In the first part of his presidential address before the Geographical Section of the British Association, Colonel Sir C. W. Wilson showed, by numerous historical references, how the trade-routes of the world are and have always been governed by physiographical conditions, and by accidents of war and human operations, which, making one route inconvenient, have compelled the opening of another. To cope with these conditions, and find and possess the best route, is one of the functions of the scientific geographer. The discovery of the Cape route was no mere accident, but the result of scientific training, deep study, careful preparation, and indomitable perseverance. Prince Henry, having determined to find a direct route to India, invited the most eminent men of science to instruct a number of young men who were educated under his own eye, and in a few years he made the Portuguese the most scientific navigators in Europe. The voyage of Vasco da Gama, with its grand commercial results, followed. For a correct determination of the lines which the shortened trade-routes and great maritime canals we are seeking to locate should

follow, a sound knowledge of geography and the physical condition of the earth is necessary; and instruction in this direction should form an important feature in any educational course of commercial geography. The great problem of the future is the inland carrying trade, and one of the immediate commercial questions of the day is, Who is to supply the interiors of the great continents of Asia and Africa, and other large areas not open to direct sea traffic? It is not altogether impossible to foresee the lines which inland trade must follow, and the places which must become centers, or to map out the districts which will be dependent on those places. These questions as to a part of Central Asia may have been partly solved by a voyage which Mr Wiggins made last year. Acting upon a conviction which he had reached by a strict method of induction, that the Gulf Stream passed through the straits into the Kara Sea, and, acting with the floods of the Obi and Yenisei, would free that sea from ice and keep it open for navigation during a part of each year, he sailed to Yeniseisk, some two thousand miles up the Yenisei, within a few hundred versts of the Chinese frontier, and landed his goods there. The science of commercial geography is not confined to a knowledge of the localities in which those products of the earth that have a commercial value are to be found, and of the best markets for them. Its higher aims are to divine, by a combination of historical retrospect and scientific foresight, the channels through which commerce will flow in the future, and the points at which new centers of trade must arise in obedience to known laws.

The Underground Waters of England.—In a paper on the underground waters in the permeable formations of England, Mr. E. E. De Rance said that the remarkable drought that that country experienced during 1887 had brought out in strong relief the advantage of public water-supplies being drawn from underground sources, where the rainfall of wet periods is not only stored in the sandstone rocks, but is delivered filtered from organic impurity and at a constant equable temperature. Notwithstanding the unprecedented period of dry weather, the public wells of Liverpool, Birkenhead, Birmingham, Southport, Nottingham, South Staffordshire, and the Staffordshire potteryworks gave their daily supply undiminished, while the gravitation works of the Manchester corporation and the whole of the east Lancashire towns were on short supply, and in some instances failed altogether. The levels taken at a well at Bocking, in Essex, for several years, showed that the water-level was uplifted by the Essex earthquake of April 22, 1884. This acquired level was gradually diminishing, at a rate which would bring back the original level by August, 1888.

Chinese Names.—The Chinaman bears his father's name; the woman, on marrying, takes her husband's name and adds her father's to it. Thus, when Miss Wang marries Mr. Ly, while she might usually be called Mrs. Ly, she must in formal acts sign herself Ly-Wang. People of the lower classes have names the character of which varies in different places. In Pekin, a number answers the purpose, and we have for Mr. Chang's sons, the elder Chang, second Chang, third Chang, etc. At Canton they add *ah* and a surname, and we have Chang-ah-brave and Chang-ah-honest, if it is a man; Chang-ah-silver, Chang-ah-pearl, if it is a woman. In Fuhkien they double the character and give Chang-stone-stone, Chang-great-great, etc. When a youth goes to school, his teacher selects a name for him consisting of two characters, such as "Five Stars," "Long Life," or some other fantastic designation; but only the teacher and the other pupils can use this surname. As soon as a young man is married, his own friends or the friends of his wife's family give him a name which is used only by members of the agnatic family; but this custom is not very faithfully observed. When a person presents himself for the public examinations, or is seeking a position, he usually chooses a name composed of two characters, which becomes the only name under which he is officially known. A person who has never been to school, is not married, and never obtains an official position, can only have his family name and his regular surname, according to the custom of the province. The school and marriage names being of little importance, persons may be classed, generally, according to their

names, as official and non-official. Those of the latter class have only their name and surname, unless they have acquired a nickname, like Chang-dog's-eye, Wang the gimlet, etc. Persons of the official class have three names: the family name; the official name, used only officially; and the private name, used by friends. On the death of an official personage, the emperor will, if he thinks best, confer upon him a posthumous name.

Improved Gas Heating Appliances.—A new gas heating appliance has been devised by Mr. Thomas Fletcher, F. C. S., of Warrington, England, who, in exhibiting it at Liverpool, fused a large hole in a plate of quarter-inch-thick wrought-iron in a few seconds, without preparation, and with apparatus which could be carried by a man up a ladder and used in any position. There is, therefore, no longer such a thing as a burglar-proof safe, for with this invention it is simply a question of minutes to fuse a hole large enough for a man to enter in any wrought-iron or steel door in existence. The professional burglar is always ready to utilize the latest applications of science, and may be expected to take this apparatus in hand. In fact, Mr. Fletcher's furnaces, designed to assist in chemical research, are used by receivers of stolen goods to reduce plate and jewelry to ingots. The form of this blow-pipe which Mr. Fletcher exhibited was noisy in action, but he stated that burglars would probably succeed in making it silent. A serious obstacle to their doing this, however, is that the machinery necessary for producing the noiseless form is both costly and large. The matter is one to which bankers and safe-makers should give their attention.

Forestry in Switzerland.—The present forestry law of Switzerland was enacted in 1876, and is applied to the mountain districts and the hills on the plains, covering about 60 per cent of the country, of which 15·8 per cent is forest-land. The rights of private owners are not affected except where their woods are "protecting" woods, or might have an influence on the climate, avalanches, land-slips, etc. All woods under official supervision have to be demarkated, clearings planted afresh, and new forests created where necessary, the Government bearing a just share of the expense. All servitudes or easements in "protecting" woods were to be redeemed in ten years, and no new ones were allowed to be created. Anything that might endanger the utility of the forests was forbidden. Cattle were not allowed to graze, and leaves could not be collected, except in fixed spots. A two months' course of education is prescribed to be given to each student of forestry by the canton to entitle it to the federal subsidy. It includes forest surveying and measurement in detail; road-making, and safeguards against avalanches; study of the different kinds of timber and of noxious plants; elementary knowledge of soils and of their component parts; fundamental notions of the laws of climate and meteorology; cultivation and care of forests; and book-keeping and other general branches of instruction valuable for underforesters. These provisions were put in operation very slowly, waiting the compliance of the cantons; and even yet each canton possesses in a measure its own scheme of forestry organization.

An Aged Spider.—In the summer of 1887 an American tarantula died, which had been in the possession of Mr. H. C. McCook over five years, and which he estimates was at least seven and perhaps eight years old. This spider, which Mr. McCook had named "Leidy," after Dr. Joseph Leidy, from whom he had received it, thus attained the distinction of having reached the greatest age of any spider known to science. The fragments of a cast skin were found near the carcass of the tarantula, indicating that it had died shortly after molting. "Leidy" had shed its skin several times during its confinement. Mr. McCook has had best success in keeping large spiders alive by feeding them a generous supply of living insects during the summer and early autumn, and withholding food almost entirely during the remainder of the year. Spiders require water quite as much as other animals. They do not become torpid in winter, if kept in a room heated to a moderate temperature. "Leidy" kept a rug-like web spread on the ground in the box which it inhabited, and when this became soiled, by earth or food *débris*, it was soon overspread with a clean layer. In this

way a thick mass of intermingled soil and silk was formed. The only effort at nest-building which it made was a rude burrow against the side of the box. This burrow was entirely destitute of silken lining, although occasionally the opening would be overspun with a thin sheet.

Origin of Archæan Graphite.—In a paper at the British Association on the origin of graphite in the archæan rocks, the Rev. A. Irving points out that the occurrence of carbon in late rocks as the result of plant-life is no argument to prove that the graphite of the archæan is of similar origin. Indeed, conditions were then so different that this mode of origin is extremely unlikely. Elementary carbon is produced in three ways: in pig-iron, by reduction of carbonic acid by alkali metals, and by contact action of heated surfaces on hydrocarbons. As hydrocarbons exist in the heads of comets, some method of origin like the last is far more probable than that the graphite should be phytogenic. The author thought that Möbius's investigations disproved the organic origin of eozoön; the iron oxides of the American archæan would come from the combustion of iron vapor in oxygen, while the unfossiliferous limestones of the archæan can be explained on purely chemical and physical principles.

The Country Schools of New York.—The State Superintendent of Public Instruction of New York, in his last report, draws an unpleasant picture of the condition of the rural schools. In them, he says, "the work done depends almost exclusively upon the character and capability of the teacher. There is no 'system' to fall back upon, no machine which will turn out passable work, whether or no. If the teacher is discerning and bright and enthusiastic, results will frequently be attained which surpass any accomplished in the great schools; if indifferent, the results are of no consequence. . . . All teachers are entitled to consideration, for their work is trying and exacting; but this is more strikingly so in the cross-roads districts than elsewhere. Their pay is small. . . . Their work is not confined to a single grade; they must meet the requirements of all grades and all classes. They must lay out their own course of study, if they have any. Text-books are frequently antiquated; there is no uniformity, even in the same school, and frequently not in the same class, and the teacher finds it impossible to work improvement. The school is very likely maintained only twenty-eight weeks in the year, just long enough to share in the public moneys. Attendance is irregular. Trustees drive hard bargains, for the number of young persons who want the place is very large. Continual change in the teachers is the order of the day. The time of employment is but for a single term, and frequently the trustee undertakes to make it by the day or the week, in order that he may be free to effect a change at any time, or that he may withhold pay, in violation of the spirit and intent of the statute, for the week occupied in attendance upon a teachers' institute. Supervision amounts to little or nothing, for distances are great, during a good part of the year roads are impassable, and it is physically impossible for the commissioner, with generally more than one hundred schools under his charge, to visit each very frequently."

The Energy in an Earthquake.—After explaining, in the American Association, the impossibility of calculating the intensity of an earthquake more than approximately, Prof. T. C. Mendenhall applied a formula to determine the energy involved in the Japanese earthquake of January 15, 1887, which disturbed over 30,000 square miles of territory. He said: "Assuming a mass of 150 pounds per cubic feet, and taking a cubic mile as the volume to be considered, I find that to put it in vibration required the expenditure of 2,500,000,000 pounds of energy. Assuming an area of 100 miles square, with a mean depth of one mile, was thus in vibration at any one instant of time—which is not improbable, considering the known rate of transmission and the long duration of the earthquake—the amount of energy thus represented would be 25×10^{12} foot-pounds. This energy might be generated by the fall, under the action of gravity, of a cube of rock 1,000 feet on each edge, the mass of which would be 75,000,000 tons, through a vertical distance of 166 feet." Also, assuming certain magnitudes, "I find the energy of a cubic mile of the Charleston earthquake,

taken near enough to the epicentrum to be disturbed, as above assumed, to be equal to 24,000,000,000 foot-pounds. The speed of transmission of this disturbance has been pretty well determined by Newcomb and Sutton to be approximately three miles per second, so that a cubic mile would be disturbed in one third of a second. To do this would require 130,000,000 horse-power. Assuming that an area about the epicentrum 100 miles square was thus disturbed, the energy would be that of 24×10^{13} foot-pounds, and the rate of its expenditure would be that of 1,300,000,000,000 horse-power."

Volcanic Explosion in Japan.—The district of Hibara Mura in Japan was visited on July 15th with a volcanic outburst of most singular character, which may be compared for violence with the recent catastrophes of Krakatoa and the Tarawera district of New Zealand. The whole of Mount Baudai, a peak nearly five thousand feet high, one hundred and fifty miles north of Tokio, was blown up, just as a steam-boiler might be, by the explosion of the vapors accumulated in the recesses beneath it. A number of villages were ingulfed, with all their inhabitants, estimated at about five hundred. The region was inundated by torrents of mud; and showers of dust, which was red at first and afterward turned gray, fell over a wide extent of country. The catastrophe, according to the accounts of witnesses who survived it, was marked with the accompaniments of fearful earth tremors, detonations which were said to sound like the firing off of all the artillery in the world at once, and a total darkening of the air for several hours. At one point a river was dammed up by the flow of mud, so as to form a considerable lake. The scene of the catastrophe was visited soon after the event by a scientific commission appointed by the Government, whose report has been published by Mr. W. K. Burton, of the Imperial University. In the view of this commission, the phenomenon differed from usual volcanic eruptions in that it left no traces of fire or lava. It was simply a violent explosion of steam. That the mountain was underlain by beds of hot water has always been indicated by the existence of hot springs on its slopes. The explosion carried off all the middle part of the mountain, including the central peak; it took a sidewise rather than a vertical direction, and scattered its *débris* to a depth of from three to thirty metres, and in one or two instances three hundred metres, over an extent of about sixty square kilometres. A remarkable feature of this disbursement is the steepness of the piles of matter in some places.

Sacred Trees of Japan.—Not the least engrossing element in researches into the flora of Japan is encountered in the traces of tree-worship here and there to be detected. In Shinti the *hi-no-ki*, the sun or fire tree (*Chamæcyparis obtusa*), is the sacred tree of predilection; the temples being constructed exclusively of this wood, even to the tiles and nails, or pegs; and from time immemorial the sacrificial fires have been kindled with drills made of hi-wood—whence perhaps its name. At the great bonzeries of Nikko, or sun-splendor, so named in the ninth century, the shrines of the Shoguns are surrounded by sugi-trees, the Japan cedars (*Cryptomeria Japonica*), which measure twenty feet in girth, and run to one hundred and twenty feet in height, contributing not a little to the force of the Japanese saying, "If you haven't seen Nikko, you mustn't say marvelous." The *shii* oak, or *Quercus cuspidata*, is also chosen for the environs of temples, perhaps because of its dense foliage, and quantities of its acorns are eaten at religious feasts. The beauteous *icho*, the *Gingko biloba* or *Salisburia adiantifolia*—also called the maidenhair-tree, from the resemblance of its leaves to the fern of that name—is also a sacred favorite. One at the foot of the staircase of the great temple at Kamakura measures twenty feet round. The Japanese consumed the almonds of this tree at religious festivals. And in northern Japan, wherever Shinto prevails, there are hallowed trees encircled with a rice-straw rope which bears tassels at intervals. The Japanese are in the habit of driving nails into the *rotesu* or *Cycas revoluta*, which yields the Japanese sago. This, they say, at the present day, is to push on vegetation; but your thoroughgoing comparative religionist is bound to detect in this survival the similar *piaculum* of the early Latins, records of which can be traced to the four hundred

and twenty-third year of Rome. It is also common among the negroes of the Guinea coast and in Persia. The idea was to drive the prayer into the body of the idol, the god, the sacrosanct and worshiped tree; and a form of the practice survives in Brittany, where saints' statues have replaced primitive idols, and women's pins do duty for nails. About six miles west of Tokio, at Habashi, is the stump of an old ye-tree (*Celtis Willdenowiana*), so covered with *ex-votos* that its fame must be surpassing. Morsels of its decayed wood are sold to those who have grown weary of their loves. The force of the remedy lies in the application of it. The tinder is boiled, the damsel is got to drink of the charm unawares, and immediately she goes her ways, and leaves her charmer to sing "Joy go with her!" The bunches of spindles which grow on the great bosses or tumors of the *shiraga-matsu* (*Pinus Thunbergii*) are still revered as the nests or lairs of the *Ten-gu*, or heavenly dog, which inhabits mountains or lonely spots, has a long snout, two claws on each foot and hand, and a pair of wings.

Protective Charms.—Charms against almost any of the ills and dangers of life can be obtained in Burmah from the Buddhist priests, for a trifling consideration. One of these Wise Men will furnish a charm warranted to protect the wearer against being shot, for five or six rupees (between two and three dollars). One of these charms, obtained by an English officer, consisted of a tiny figure of Gaudama, in a sitting posture, not much exceeding a large pea in size, carved in ivory. In order to become proof against sword-wounds, a medicine made by the priest must be eaten. A specimen of this medicine resembled in appearance and odor dried leaves or bark finely powdered. Charms for other purposes consist of curious devices tattooed on various parts of the breast and shoulders; also of bits of ivory, silver, lead, etc., inscribed with magic spells, inserted under the skin. The Burman's faith in these charms is very deep-rooted, and in spite of frequent and painful proofs of their fallibility he does not seem to lose confidence in their magical properties. The injured man himself is generally the first to find an excuse for the failure of his talisman to protect him. Holders of gun-charms assert confidently that a gun fired at them will not go off, or will burst, but their faith is not so strong that they will consent to an experimental test.

Dr. Nansen's Greenland Expedition.—Dr. Frithiof Nansen has successfully accomplished the experiment which we described several months ago as about to be undertaken, of crossing Greenland from the eastern to the western side, and arrived at Godthaab on the 3d of October last. The party had some difficulty, owing to a southerly drift in which they were caught, in making a landing on the eastern coast as far north as they desired, but finally started to cross the inland ice from Umiavik, latitude 64° 30′, on the 15th of August. A course was at first set toward the northwest for Christianshaab, in Disco Bay; but much time being lost through severe northerly snow-storms, Dr. Nansen was compelled to turn to the westward for the nearer settlement of Godthaab. The western coast was reached after forty-six days' traveling, the distance from the point of departure being 280 geographical miles. For several weeks the explorers were at an altitude of more than 9,000 feet above sea-level, and suffered from snow-storms and loose snow, and a temperature of between 40° and 50° below freezing. As the last Danish ship of the season was not able to wait for them to be embarked upon it, the party will have to spend the winter in Godthaab.

Longevity of Professional Men.—The comparative longevity of professional men may be accounted for by reference to the exceptionally favorable conditions under which they exist. While the man who is in trade is tormented by anxiety over the uncertainties of the morrow, and the man who has made a fortune and retired is, unless he has cultivated a hobby, a prey to inanition, and liable to feel that he has no longer a welcome place in the world, the professional man of fifty has learned what he can do, and has adjusted himself to a career for which he is fitted. If he is making a fortune, his life is full of interest and brings little trouble or anxiety to himself. It is not his own case that the lawyer pleads, the physician com-

bats, and the parson arraigns. If he is only moderately successful, his earnings, though small, are safe, and he may hope that his future will be as happy as his past. His occupation, meanwhile, brings him consideration and intelligent surroundings, and his life is fairly and pleasantly varied. These things all contribute to length of life.

NOTES.

THE seventh annual meeting of the American Forestry Congress was held at Atlanta, Ga., December 5, 6, and 7, 1888. Papers and addresses on various subjects pertinent to forestry in America were given. The Congress has for its object the creation of a public sentiment in favor of a more rational treatment of our forest resources. It is proposed to raise a fund of ten thousand dollars for carrying on the work of the Congress, by creating life-memberships of one hundred dollars each. The management of the principal fund is to be in the hands of the subscribers to it, who will be known as patrons.

THE programme for the second triennial session of the International Congress of Hydrology and Climatology, which is to be held in Paris in October, 1889, includes questions upon scientific hydrology, medical hydrology, and climatology. The membership fee is twelve francs.

ACCORDING to Mr. Thomas T. P. Bruce Warren, the better descriptions of India-rubber, which are obtained from Brazil and Central America, are now so eagerly sought after for the markets of the United States and Germany that the British no longer have the monopoly of the industry. Yankees are so frequently at Pará that they have virtually the run of the market for the raw article there, so that British customers have often to take what would not pass muster for them.

DR. LUDWIG WOLF relates that while the natives of Africa usually meet the white man with suspicion and hostility, the Baluba people at once showed his party a blind, childlike confidence. They greeted them as former deceased chiefs and relatives of their king Kalamba Mukenge, by whose names they always called them. This was in pursuance of their belief that all distinguished warriors and chiefs will return to them metamorphosed after death.

MR. PROCTOR left the manuscript of his "Old and New Astronomy" in a more advanced state than was feared. Its completion has been undertaken by Mr. A. C. Ranyard, who was for some time Secretary of the Royal Astronomical Society.

ARSENIC having been recommended by Dr. Tommasi Crudelli as a substance that will efficiently augment the mean resistance of the human organism to the malarious ferment, Dr. Ricchi, medical supervisor of Italian railways, has adopted as a tonic food-preparation, to aid the preventive virtue of the arsenic, the impalpable soluble powder, made from the "sterilized" and desiccated blood of calves, which is known in commerce as "trefusia." Dr. Tommasi Crudelli approves the preparation, as being adapted to the condition of systems which are not susceptible of protection by the arsenical treatment alone. The same physician recommends decoction of lemon as a prophylactic or remedy in cases in which arsenic and quinine have failed.

SUDDEN deaths are most frequent, according to "The Lancet," when the conditions of life change suddenly, or are especially liable to change—and this without necessary reference to whether the change effected be relatively for the better or for the worse; for the change may be so rapidly effected, in either direction, as to throw upon the circulatory and respiratory functions a strain which the organs are not able to bear. In this way, persons with unsound or weak hearts or weak arteries die suddenly under rapid changes, although, if there were no special strain consequent on the change, it would in itself prove advantageous to them. It may be accepted that sudden deaths are especially likely to occur at periods of seasonal change, and at times when rapid variations of temperature are taking place.

PROF. H. J. MACKINDER, Reader of Geography at the University of Oxford, expresses the opinion that the best preliminary training for a geographical specialist is a sound grounding in general science, and, superadded to this, an elementary knowledge of history. He has found by experience that it is exceedingly hard to give the necessary scientific knowledge to a historian.

PROF. MACKINDER'S courses in geography at Oxford for 1888–'89 will include lectures on "The Physical Geography of the Continents"; "The Geography of the British Isles, with Especial Reference to History"; and "The Historical Geography of North America." To these will be added lectures by Prof. Freeman on the "Historical Geography of Europe," and by the Reader in Indian History on "The Geography of India." Besides his duties at the university proper, Prof. Mackinder last year gave one hundred and two extension lectures on geography and physiography at ten towns.

THE operation of transplanting a part of a nerve from a rabbit to a man has been successfully performed in Vienna, upon Prof. von Fleischl, of the university. The professor had lost his thumb and incurred neurotoma,

and was suffering much pain. A piece, six centimetres long, was taken from the great nerve of a rabbit's thigh so as to include the natural bifurcation of the main trunk. It was secured to the stump of the nerve in the man's arm, and the ends of the branches to the nerve terminations that remained in the fingers, so as to restore the interrupted communication. All had gone well at the end of two months.

AN "authorized" biography of the late Sir William Siemens has been prepared by Dr. William Pole, of the Society of Civil Engineers, and will soon be published in London.

MR. PROCTOR'S "Knowledge" will be carried on in future by W. H. Allen & Co., London, as an illustrated magazine, with more space devoted to physics, biology, etc., and with controversial articles on theological and allied questions excluded.

A NEW mole-like mammal, found in South Australia, is described by E. C. Stirling, of the university at Adelaide. It is a ground-burrowing animal, outwardly somewhat like the Cape mole, but differing from it in many respects. It is about five inches long, has no visible eyes, but a small pigment spot to be seen on reflecting the skin, where the eye should be; no external ears, but the ear-openings distinct and covered with fur; the fore-limbs short, resembling those of the mole, with the hands folded so that only two of the nails are visible in the natural position; and the hinder limbs also short, with the soles turned outward. The animal had never been seen by any of the aborigines, except by one old woman once.

A STATUE of Ampère was unveiled at Lyons, his native place, October 9th. The President of the French Republic attended the ceremony, and M. Cornu, of the Academy of Sciences, delivered the address.

THE Copley medal of the Royal Society for 1888 was presented to Prof. Huxley, for his investigations into the morphology and histology of vertebrate and invertebrate animals, and his services to biological science generally; the Rumford medal to Prof. Tacchini, for his researches in solar physics; and the Davy medal to Mr. Crookes, for his researches on the electric discharge in high vacua. Royal medals were awarded to Baron Ferdinand von Mueller, the Australian botanist, and to Prof. Osborne Reynolds, of Owens College, for researches in mathematical and experimental physics.

M. MARAMBET reports that of 3,000 convicts in France, examined with respect to their habits of drunkenness or temperance, 79 per cent of vagabonds, from 50 to 57 per cent of assassins and incendiaries, 53 per cent of offenders against morals, 71 per cent of thieves, sharpers, etc., 88 per cent of offenders against the person, and 77 per cent of offenders against property, were drunkards. Drunkards are nearly as numerous among youths under twenty as among adults. The largest numbers of drunkards came from regions where spirits are most largely consumed.

AN elaborate work on "The Viking Age," by M. de Chaillu, is soon to be published. It will present the early history, manners, and customs of the ancestors of the English-speaking nations, illustrated from the antiquities discovered in mounds, cairns, and bogs, as well as from the ancient Sagas and Eddas, with more than one thousand pictures.

MEXICO affords a curious example of the demoralization which irrational tariffs work. To prevent bribery, the law imposes a system of fines and forfeitures of which the officers detecting irregularities are entitled to half. Foreign shippers rarely escape fines on their first consignments to Mexican ports, because, unless they are experts, or consult experts, they are very sure to have some flaw in their papers which the sharpened eye of the customs detective can fix upon as a pretext for levying a fine. The absence of a consular invoice is equivalent to the infliction of double duties, and this is often equivalent to confiscation. "Insufficient declaration" is punished by fines rising from ten to one hundred per cent on the duties, according to the nature of the offense.

The Indian system of weights and measures is described as being exceedingly confusing, because of the numerous different designations of the standards, and because the same designation may be applied to different standards, according as the articles differ, or as the transactions are held at different places. A maund of barley is not the same as a maund of indigo or of cotton, and a Bombay maund is different from a Calcutta maund. A seer is 5,040 grains, while five seers are not five times 5,040 grains, but five times 4,900 grains, to make them commensurate with the Bombay maund.

AT the anniversary meeting of the Sanitary Institution of Great Britain, Mr. Edwin Chadwick, chairman, claimed credit to that and similar institutions for a large proportion of the reduction of the death-rate of the metropolis, which had fallen to 14 in 1,000. The rate in Paris is 27, in Vienna, 30, and in St. Petersburg 40 per 1,000. Dr. B. W. Richardson delivered an address on "The Storage of Life as a Sanitary Study," by which he meant, substantially, the art of living long.

WHILE the summer of 1888 was unusually cool and moist in the United States and the most of Europe, the people of Norway endured a heat which is said to have surpassed the highest before observed during this century.

"THE sight-seer's headache" is the name given to an affliction from which frequenters of picture-galleries and museums suffer. It is a result in part of the effort of the mind consequent upon long-continued observation, and partly of the muscular strain involved in that work; but is chiefly produced—in sufferers who are burdened with catalogues—by the frequent movement of the eye from the book to the object, and the incessantly repeated readjustments of the focus of vision which are made necessary in looking now at one, now at the other.

THE advance that has been realized in the power of sanitation is exemplified, according to Mr. Edwin Chadwick's review, in the military services of the United Kingdom. A quarter of a century ago, the death-rate in the Guards was 20 per 1,000; it is now 6½ per 1,000. The death-rate in the home army has been reduced in the same time from 17 to 8 per 1,000. In the Indian army the old death-rate was 60 per 1,000; from 1879 to 1884 it was reduced to 20 per 1,000; and it is now about 14 per 1,000. In the six years from 1879 to 1884, the aggregate saving was 16,910 lives, the money value of which is estimated at £1,691,000.

GENERAL PITT RIVERS has remarked that the difference in results caused by different methods of estimating the same skeleton by the most famous English physical anthropologist is not less than four inches. Dr. Beddoe proposes as a rule to add to thrice the length of the femur in inches 13 inches, and one half of any excess over 19 inches in the case of a man, reading 12½ and 17½ in the case of a woman.

A FAVORABLE report was given of the growth and prospects of the Bridgeport (Conn.) Scientific Society at the opening of the lecture course of 1888–'89. The society puts actual work and investigation by its members foremost among its objects, while the lectures are a secondary consideration. It is about to be endowed with a permanent home through the liberality of Mr. P. T. Barnum. Mr. Barnum made the opening address of the season's lectures, and having spoken of the benefits which science has conferred upon mankind, urged prompt and full recognition of the city's benefactors.

THE origin of the experimental farm at Rothamstead is attributed in the "Pall Mall Gazette" to a remark made to Mr. Lawes by Lord Dacre to the effect that bones used as manure produced excellent results on one farm, while on another they were comparatively useless. This led to the institution of experiments with different fertilizers. Sir John Lawes is arranging to put his laboratory and the land on which the experiments have been made, with £100,000 as an endowment, into the hands of trustees to be appointed by the Royal and two other societies. Thus there will be no end or interruption to the work after the death of Dr. Gilbert and himself.

SPECIMENS of what may prove to be a new species of chimpanzee have been attracting attention at the London Zoölogical Society's gardens. They are characterized by being bald-headed—are possibly identical with M. Du Chaillu's *Troglodytes calvus*—and the name *Anthropopithecus calvus* has been provisionally given them. Living specimens of all the three known anthropoid apes may now be seen at the society's houses.

AN expedition is projected in Norway to be dispatched in the summer of 1890 in an attempt to reach the north pole by way of Franz-Josef Land. The leadership of it is to be offered to Dr. Nansen.

THE crater lakes of the volcanic Eifel have been found by Dr. Otto Zacharias to be inhabited by numerous species of *Copepoda*, *Daphnidæ*, *Radiolaria*, *Rotiers*, water-mites, and insect larvæ. The largest of them, the Laacher See, which is about seven miles in circumference, contains a special fauna.

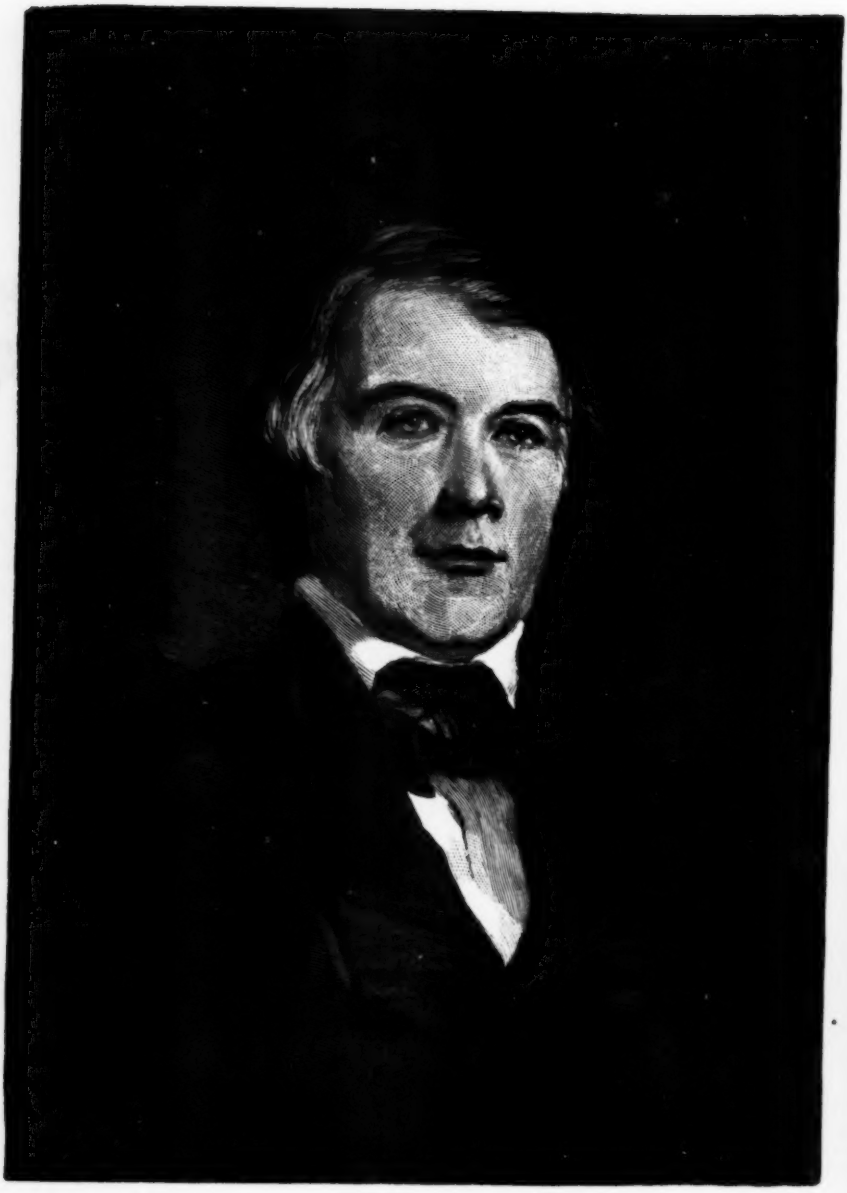
PARTS of the monument that was erected in London by Sir Christopher Wren, to commemorate the Great Fire, are showing signs of decay. The limestone of which it is built is acted upon by the acids of the London atmosphere—an agency which had no perceptible existence in Wren's time, but is becoming more and more obvious in large cities and manufacturing towns.

OBITUARY NOTES.

PROF. RICHARD VINE TUSON, of the Royal Veterinary College, London, died October 31, 1888. He had been Professor of Chemistry in the institution named for more than twenty years; was a "thorough chemist and able teacher and experimenter"; and was the author of various scientific papers, and editor of the new edition of Cooley's "Dictionary of Receipts."

DR. PETER GRIESS, a British chemist, died at Bournemouth, September 6th. He was best known as the discoverer of those remarkable substances, the diazo-compounds.

DR. NATHAN ALLEN, of Lowell, Mass., a physician and medical writer well known to readers of the "Monthly," died on the 1st day of January, from the effects of a fall down-stairs resulting in concussion of the brain. He was distinguished as a specialist in the subjects of physical culture and degeneracy, insanity and state medicine, heredity, hygiene, education, intemperance, and the family institution, and particularly of the falling off in the birth-rate among native New England families; on these subjects he published several important works and numerous shorter articles.



JAMES P. ESPY.